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GRAPHICS IN THE CORPS. PROCEEDINS OF THE COMPUTER GRAPHICS COLL--ETC(U)
1978 J M JONES, R L HALL, N RADHAKRISHNAN

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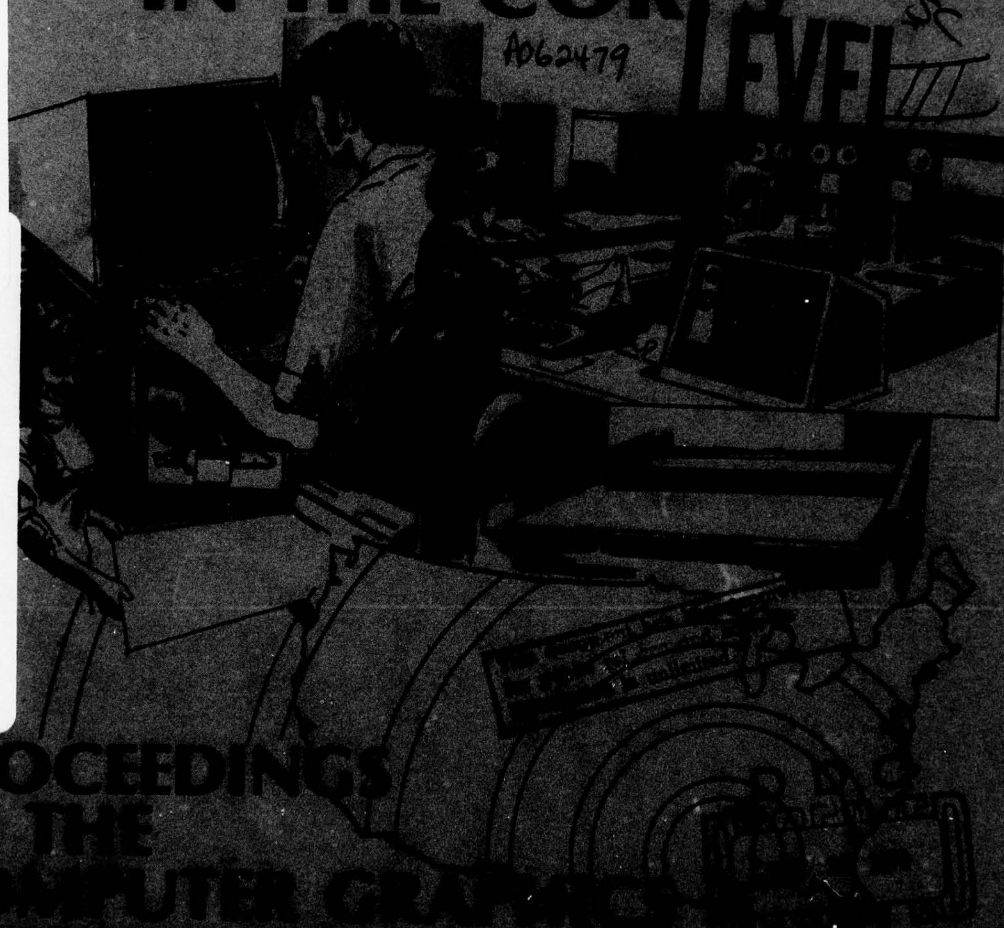

PROCEEDINGS OF THE COMPUTER GRAPHICS COLLOQUIUM

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(6) GRAPHICS IN THE CORPS.

Proceedings of the Computer Graphics Colloquium, 1-3 August 1978, United States Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.
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PROCEEDINGS OF THE COMPUTER GRAPHICS COLLOQUIUM

1-3 AUG 1978

VOL I—PAPERS AND PRESENTATIONS

Compiled and Edited by:
(10) James M. Jones, Robert L. Hall ~~and~~ N. Radhakrishnan

U. S. ARMY ENGINEER
WATERWAYS EXPERIMENT STATION
Vicksburg, Mississippi 39180

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PREFACE

Computers are being increasingly used by engineers in solving design and analysis problems. A primary factor contributing to that use is the development of computer graphics techniques. Computer graphics has made the computer a workable tool for the engineer as it gives him more information than pages full of numbers.

Since 1973, the U. S. Army Engineer Waterways Experiment Station (WES) Automatic Data Processing (ADP) Center has been very active in research in computer graphics and promoting interactive graphics applications to field office engineers. The WES ADP Center conducted the first graphics colloquium in February 1975. These efforts were made possible through funds provided by the Computation and Analysis Section, Civil Works Directorate, Office, Chief of Engineers (OCE), to support projects on "Interactive Graphics Programs for Engineering Design" and "Maintenance and Improvement of the Graphics Compatibility System (GCS)." Also, OCE provided R&D support for several graphics projects through the Scientific and Engineering Division, Engineer Information Data Systems Office (EIDSO), under project AT11 (ISRAD).

Since 1975, through the combined efforts of the WES and the OCE, there has been a tremendous growth in computer graphics applications in the U. S. Army Corps of Engineers Division and field offices. This growth was recognized at the October 1977 INFOCORP meeting in which a special Graphics Users Committee (GUC) was established to address the needs for graphics and dissemination of graphics information. Based on the recommendation of the GUC, OCE supported WES in hosting the Second Graphics Colloquium.

The colloquium was held at WES, 1-3 Aug 78. The objective was to bring together people from throughout the Corps who were involved in developing and supporting graphics activities in their offices. Over 100 participants representing 11 Division offices, 22 District offices, and three Corps laboratories attended the colloquium. Speakers from the field offices addressed the graphics applications that are currently being pursued by their offices. Speakers from the R&D laboratories addressed graphics applications developed for field offices' use and other future developments. The interactive and passive workshops informed participants on using existing graphics programs and provided a forum to discuss the future needs of computer graphics.

over

The Colloquium Proceedings are published in two volumes. All papers and abstracts of the presentations and workshops are included in Volume I. Volume II contains the abstracts of computer graphics programs being used by the Corps' offices.

Several people contributed toward making this colloquium a success. The editors would like to thank all the speakers, authors, and session chairmen for their interest and participation. The following members of the INFOCORP Graphics Users Committee worked enthusiastically to ensure the success of the Conference:

Jim Dahlen, Seattle District
Robert Hall, WES
Bob McMurrer, DAEN-DSE (OCE)
Al Montalvo, Ft. Worth District
Jim Jones, WES
John Lambrecht, Nashville District
Jim Waller, Wilmington District
Don Phillips, Jacksonville District
Ed Stone, Huntington District
Harry Hardin, OCE

These two volumes of the Proceedings were compiled and edited by Messrs. James Jones II, Robert Hall, and Dr. N. Radhakrishnan, ADP Center, WES, under the general supervision of Mr. D. L. Neumann, Chief, ADP Center. Commander and Director of WES during the Colloquium and the preparation of this report was COL John L. Cannon, CE. Mr. Fred R. Brown was Technical Director.

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AGENDA

COMPUTER GRAPHICS COLLOQUIUM

Theme: Graphics in the Corps
1-3 Aug 78

Waterways Experiment Station

31 Jul 78		
	7:00 - 9:00 p.m.	Ice Breaker
1 Aug 78		(All meetings will be held in the Main Conference Room)
	8:30 - 8:45 a.m.	WELCOME - Executive Office and C/ADP Center
	8:45 - 9:00	OVERVIEW - Bob Brittain, Memphis Dist.
		1. Introduction - Bob Brittain
	9:00 - 9:45	2. History of Graphics in Corps - Harry Hardin, OCE
		3. Graphics Users Committee (GUC) - Report - Harry Hardin
	9:45 - 10:00	BREAK
		SOFTWARE - Harry Hardin
	10:00 - 10:20	1. CALCOMP - Bob Williams, Kansas City Dist.
	10:20 - 10:40	2. DISSPLA/TEL-A-GRAF - John Lambrecht, Nashville Dist.
	10:40 - 11:00	3. PLOT-10 - Bill McDonald, Rock Island Dist.
	11:00 - 11:20	4. GPLOT - Kline Bentley, Jacksonville Dist.
	11:20 - 11:50	5. GCS/BIGS - Jim Jones, WES
	11:50 - 12:10 p.m.	6. Summary - N. Radhakrishnan, WES
	12:10 - 12:30	HARDWARE - Jim Dahlen, Seattle
	12:30 - 1:30	LUNCH
	1:30 - 2:50	R&D ORGANIZATIONS - Jim Jones
		1. WES
		a. Fred Tracy, ADP Center b. Lee Butler, Hydraulics Lab c. Bob Cole, Structures Lab d. Vic LaGarde, Environmental Lab
	2:50 - 3:15	BREAK

A G E N D A

1 Aug 78 - Cont'd

3:15 - 3:45	2. ETL - Wes Shepherd
3:45 - 4:15	3. CERL - Janet Spoonamore
4:15 - 5:45	DEMONSTRATION OF GRAPHICS EQUIPMENT
7:00	DINNER

2 Aug 78 (Meetings to be held in Main Conference Room & F-2 Classroom)

8:30 - 10:00 a.m.	CONCURRENT INTERACTIVE PASSIVE SESSIONS
	Interactive Session
	Co-Chairman - Bob McMurrer, EIDSO and Robert Hall, WES
	Passive Graphics Session
	Co-Chairman - John Lambrecht and Ed Stone
10:00 - 10:15	BREAK
10:15 - 11:45	CONTINUE CONCURRENT SESSIONS
11:45 - 12:30 p.m.	HEC2 GRAPHICS
	Co-Chairman - Al Montalvo, Ft. Worth Dist. and Art Pabst, HEC
	PARALLEL SESSION
	DEMONSTRATION OF GRAPHICS EQUIPMENT
12:30 - 1:15	LUNCH
1:15 - 2:45	FLIP FLOP SESSIONS
2:45 - 3:15	BREAK
3:15 - 4:30	CONTINUE SESSIONS
8:00	GOLD IN THE HILLS - Special showing - Little Theater Auditorium

3 Aug 78 (Meeting to be held in Main Conference Room)

8:30 - 9:00 a.m.	REPORT OF INTERACTIVE SESSION - Robert Hall
9:00 - 9:30	REPORT OF PASSIVE SESSION - John Lambrecht
9:30 - 10:00	BREAK
10:00 - 10:15	HEC2 REPORT - Al Montalvo
10:15 - 10:45	DISSEMINATION OF GRAPHICS INFORMATION - Harry Hardin
10:45 - 11:15	CRITIQUE
1:00 - 3:30 p.m.	Optional WES Tour

OVERVIEW

HISTORY OF COMPUTER GRAPHICS IN THE
U. S. ARMY CORPS ON ENGINEERS

BY

HARRY F. HARDIN

Before I can discuss the history of computer graphics in the Corps of Engineers, I must give a little background on the computers that have been used in the Corps. In 1955, digital computers were making their appearance on the market for day-to-day use of engineering applications. The engineers in the Corps realized that the computer could be used to help accomplish their workload.

In 1957, an IBM 650 was installed in the Corps at the Waterways Experiment Station (WES). It had a card reader and card punch, but had no on-line printer. As computer technology advanced to larger, faster and more sophisticated equipment, so did the Corps progress in its need and use of digital computers. The IBM 1620 and General Electric G-225 computers were installed in the Corps. The workload for business applications began to grow along with that for scientific and engineering (S&E) applications. This increased work load resulted in installation of General Electric G-437 computers in the Division Offices. The GE 225 and G437 computers are now dedicated to processing the Corps of Engineers Management Information System (COEMIS). Scientific and engineering application during the mid 1960's made use of time-sharing services that were being supplied. These services were obtained from commercial as well as Federal data processing centers. The Corps installed the Honeywell G-635 in May 1973 at WES to meet some of the scientific and engineering (S&E) application needs. The North Pacific Division has installed IBM 360 and 370 computer systems to meet its needs for support of the Columbia River Operational Hydronet and Management System (CROHMS).

During the period from 1957 to the present the Corps has provided computer services to its employees. Engineer users have also found that the computer has not met all of their needs and has in some instances

created a monster. This monster provides untold amounts of data that may or may not be needed. What is an answer to some of these problems? I propose that an answer to some S&E applications is the use of computer graphics. Computer graphics can:

a. eliminate massive paper output

b. give the engineer results in a form he can readily understand (graphs)

c. save time and money.

As an example, let us examine the application of finite elements. This procedure involves initially the description of each small (finite) element of an object. This process is long and tedious. Each element must be numbered, each corner of the element (node) must be numbered and the x,y,z, coordinates furnished. This process is repeated for all nodes. After this procedure is completed and checked, the analysis can be processed. For an engineer to run a finite element analysis he must:

a. manually divide the structure into its elements

b. provide element numbers, nodes, and x,y,z, coordinates

c. punch this data

d. process the data on the computer

e. apply the output results,both numerical and graphical.

Using interactive computer graphics, the engineer uses the cross hairs on the terminal to build the elements. The computer automatically numbers each element, node, and corresponding coordinate. The final diagram can be developed and displayed by the terminal. A sample problem was selected to illustrate the saving that can be attributed to interactive graphics. The cost analysis was as follows:

	Manual Procedure	Interactive Graphics
Labor	$950	$260
Computer	120	320
Plotter	6	6
TOTAL	$1076	$ 586

This is typical of savings that can be achieved by use of Interactive Computer Graphics by the engineer and technician.

Assuming we agree on the need for Computer Graphics, I would propose the definition of a few terms to set the stage for our discussions. In preparing for this Colloquium, the Graphics Users Committee wrestled with the terms Passive and Interactive Graphics. Passive Graphics is defined as the ability to generate a graphics representation (picture) of Computer Data. Examples of this type of plotting involve use of the off-line plotting devices, e. g. the CALCOMP drum and flat-bed plotters. Some (but very few) off-line plotters are driven on-line by the GE225 in the District Offices. Passive Graphics also, with this definition, can be applied to the same display of a picture on the CRT-type terminals. Interactive Graphics is defined as the ability to interact with the picture. Thus, an interactive graphics program will permit the user to display computations graphically, interact with the display (CRT) thru the cross hairs and so modify the display. Interactive applications are normally processed using a refresh or storage tube terminal. A refresh storage tube terminal is similar to the tube of a television (TV) in that the picture is replotted every tenth of a second. This feature is used in interactive applications to remove or add lines to an existing plot without having to retransmit and redraw the entire picture. A storage tube terminal displays the plot on the screen with only a single transmission of the data and any change in the plot, through interaction, must be accomplished by retransmission of the data. The advantages and disadvantages of each type are as follows:

Terminals	Advantages	Disadvantages
Storage Tube	1. Flicker free	1. No selective erase
	2. High data density	2. Slow drawing capability
	3. Inexpensive (4-20K)	3. Must redraw entire picture to make updates
	4. Computer treats like teletype	
Refresh tube	1. Selective erase	1. Flicker with high density
	2. Fast drawing/dynamic image movement	2. Generally requires mini-processor
		3. Costly ($50-200K)

Examples of storage tube terminals are the Tektronix 4010, 4012, 4014, etc. The ADDS 900 is a refresh tube terminal. The Tektronix 4081 provides both storage capability with a limited amount of refresh capability.

How have we in the Corps progressed in the utilization of computer graphics? The first plotting application using the line printer was developed in 1958. The plot was produced using the on-line printer and approximately three pages of coding. These plots were crude but provided the capability to display data in a graphical form. This type of plotting was primarily used to display curves and statistical-type data. In 1960 the first drum plotter was installed in the Corps and has been used both off-line and on-line. This was the advent of plotting in the Corps. CALCOMP, Hewlett-Packard, Gerber and other manufacturers placed their hardware and software in the marketplace and the Corps was off and running with their equipment. During the 1960's the Cathode Ray Tube (CRT) Technology was being adapted to computer terminal requirements. The Corps installed its first storage tube terminal in 1970 to develop the first interactive graphics program. This was another giant step for the Corps in the area of computer graphics. The storage tube terminal is a most cost-effective tool for use by Engineers in the Corps. As always the state of the art in computer graphics kept on marching. The refresh CRT was developed to provide immediate changes to existing plots and to have dynamic movement of the images. The Corps in 1972 installed its first refresh terminal. This technology has been, up until recently, too costly and it lacks sufficient software to be as effective within the Corps. The off-line (drum/flat bed) plotting and CRT storage tube terminal made their move from the research and development (R&D) area to the functional user in a very short period of time. Refresh graphics has not experienced this growth rate but appears to be on the threshold of "busting loose." In 1974 the Corps had experienced 15 years of growth in the application of computer graphics and was beginning to use the "new" CRT technology. In April 1974 the Waterways Experiment Station conducted an Engineering Computer Graphics Colloquium. The primary purposes of this

first graphics colloquium were to bring together the users of graphics to review Corps usage of graphics and to review the state of the art. The proceedings of this colloquium were published and furnished to all field offices within the Corps.

With this growth in graphics we have now come some 20 years and have under our belts a great amount of graphics expertise. Engineering disciplines for which we have developed software include:

a. contouring
b. structural design and analysis
c. slope stability
d. hydraulic structure design and analysis
e. bridge design
f. hydraulics and hydrology
g. earthwork
h. finite element grid generation
i. geotechnical applications
j. stress analysis
k. 3-D/color stress analysis.

These are only a few examples of applications that are used within the Corps. These and many other applications will be discussed in detail during these next two and a half days.

In preparing for this, the second Graphics Colloquium, a questionnaire was sent to all Corps offices. It was designed to collect information on the status of graphics hardware and software now in the Corps. Replies were received from all activities within the Corps. Tabulation of the replies indicate the following equipment is installed in the Corps:

Type	Number	Percent Total
a. Drum Plotters	34	21
b. Flatbed Plotters	9	6
c. Storage Tube Terminal	93	59
d. Refresh (Intelligent) terminals	10	6
e. Other	13	8

Each installation was requested to furnish an abstract of graphics applications they had developed that could be of use to some other

Corps office. The response from 36 offices with 87 applications was as follows for graphics language used:

Language	Number	Percent Total	No. Corps Offices
CALCOMP	42	48	17
GPLOT	10	12	1
Plot 10	5	6	4
Plot 50	3	3	3
Phil	3	4	1
Other	3	3	3
GCS	21	24	7
TOTAL	87	100	36

The program abstracts were sorted by application area with the following results:

Area	Number	Percent Total
HEC 2	11	13
Hydraulics	13	15
Structures	5	6
Soils	3	3
General Plots	20	23
3-D Display	4	5
Surveying	28	32
RA/PM	3	3
TOTAL	87	100

In discussing the history of graphics in the Corps the subject would not be complete without some discussion of the Graphics Compatibility System (GCS). Two graphics computer languages, GCS for interactive and CALCOMP for passive, have played a major part in the development of computer aided graphics for the Corps. The details of these, as well as other graphics languages, will be covered later this morning. I would like at this time to discuss the background of GCS.

In 1972 the WES ADP Center had been using the CALCOMP CRT plotter and Tektronix 4010 and 4012 CRT terminals and the ADDS 900 for about two years. They realized at that time the need to find and use one graphics language. The computer graphics market was beginning to be flooded with different graphics languages and equipment, thus the potential need for one graphics language to support all types of terminals. Engineering Division of the Civil Works Directorate in conjunction with the WES ADP Center Computation and Analysis Branch began to study the state of the art in computer graphics. Visits were made to other agencies, commercial vendors, universities and colleges, and in general to the experts in computer graphics. The primary graphics languages investigated in detail were:

a. ADDS 900

b. Tektronix Plot-10

c. West Point GCS.

GCS was selected and obtained from West Point. It was selected for the following reasons:

a. was a state-of-the-art graphics language

b. all subroutines written in FORTRAN

c. operational on Honeywell equipment

d. supported multiple graphics devices

e. was a non-proprietary software package

f. West Point maintenance and support of the system

g. it had been field tested and used by other agencies.

After selecting GCS, WES and OCE began conversion of some existing graphics programs and development of state-of-the-art R&D programs. From the R&D efforts came the engineering applications designed for the user in the District and Division offices. The first fruit of this effort was the graphical frame analysis program named STRUPUT. As with any new language, GCS had to be taught to the using engineer and classes were and still are being provided.

GCS use and acceptance expanded to other offices in the Corps and interactive applications were being developed by the user. In 1975 West Point advised that they were no longer able to continue support

and development of GCS. General Morris, Chief of Civil Works, sent a letter to the Engineer Information and Data Systems Office (EIDSO) indicating the need to continue using GCS and to offer financial support to insure its continued availability. As a result, in January 1976, administrative responsibility for GCS support and maintenance was transferred from West Point to the WES ADP Center. Since that time GCS has been maintained by WES and supported by the Directorate of Civil Works, Research and Development Office, and EIDSO. GCS has been used by other federal agencies, several universities and colleges, industries both in the USA and abroad, and is operational on most existing computer hardware, including mini-computers. GCS is used by 15 offices in the Corps. Training is provided by the WES ADP Center and is supported by the Office Chief of Engineers. GCS training for the field offices began in December 1975. Since that time eight classes have been conducted and sponsored by the Computation and Analysis Branch of Engineering Division, Civil Works. Two Districts have requested and received GCS training. Over 150 Corps personnel have been trained since 1975 which brings the total to approximately 300. WES continues to improve and enhance GCS to keep it in tune with the state of the art.

During this short period of time I have tried to cover the progression of graphics in the Corps of Engineers. My coverage of the hardware and software have been, through design, general in nature. I hope that I have given just enough information to stir up many questions that will be answered by the remaining speakers and most of all tomorrow by each of you as you share your graphics expertise in the interactive and passive sessions.

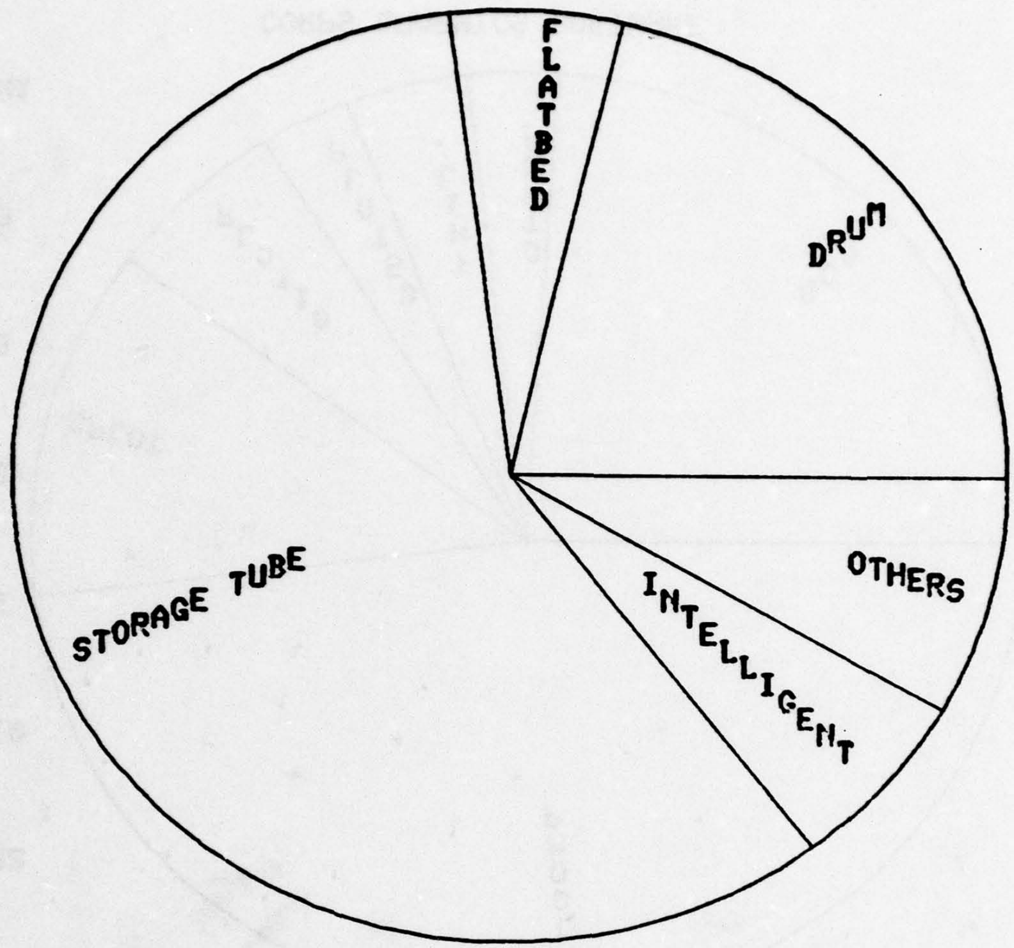
DRUM - 21%
EQUIPMENT TOTAL = 34

FLATBED - 6%
EQUIPMENT TOTAL = 9

STORAGE TUBE - 59%
EQUIPMENT TOTAL = 93

INTELLIGENT - 6%
EQUIPMENT TOTAL = 10

OTHERS - 8%
EQUIPMENT TOTAL = 13



CORFS GRAFHICS HARDWARE

CALCOMP - 48%
PROGRAM ABSTRACTS = 42
CORPS OFFICES = 17

GPLOT - 12%
PROGRAM ABSTRACTS = 10
CORPS OFFICES = 1

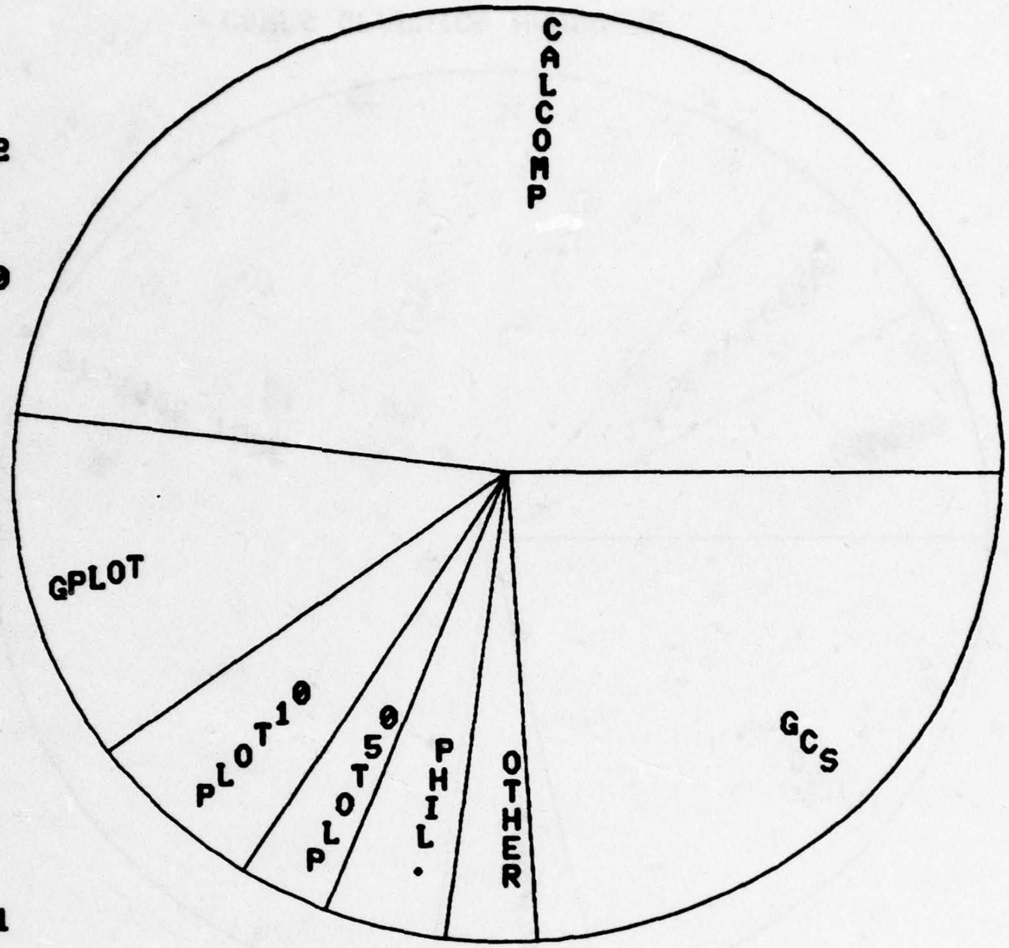
PLOT10 - 6%
PROGRAM ABSTRACTS = 5
CORPS OFFICES = 4

PLOT50 - 3%
PROGRAM ABSTRACTS = 3
CORPS OFFICES = 3

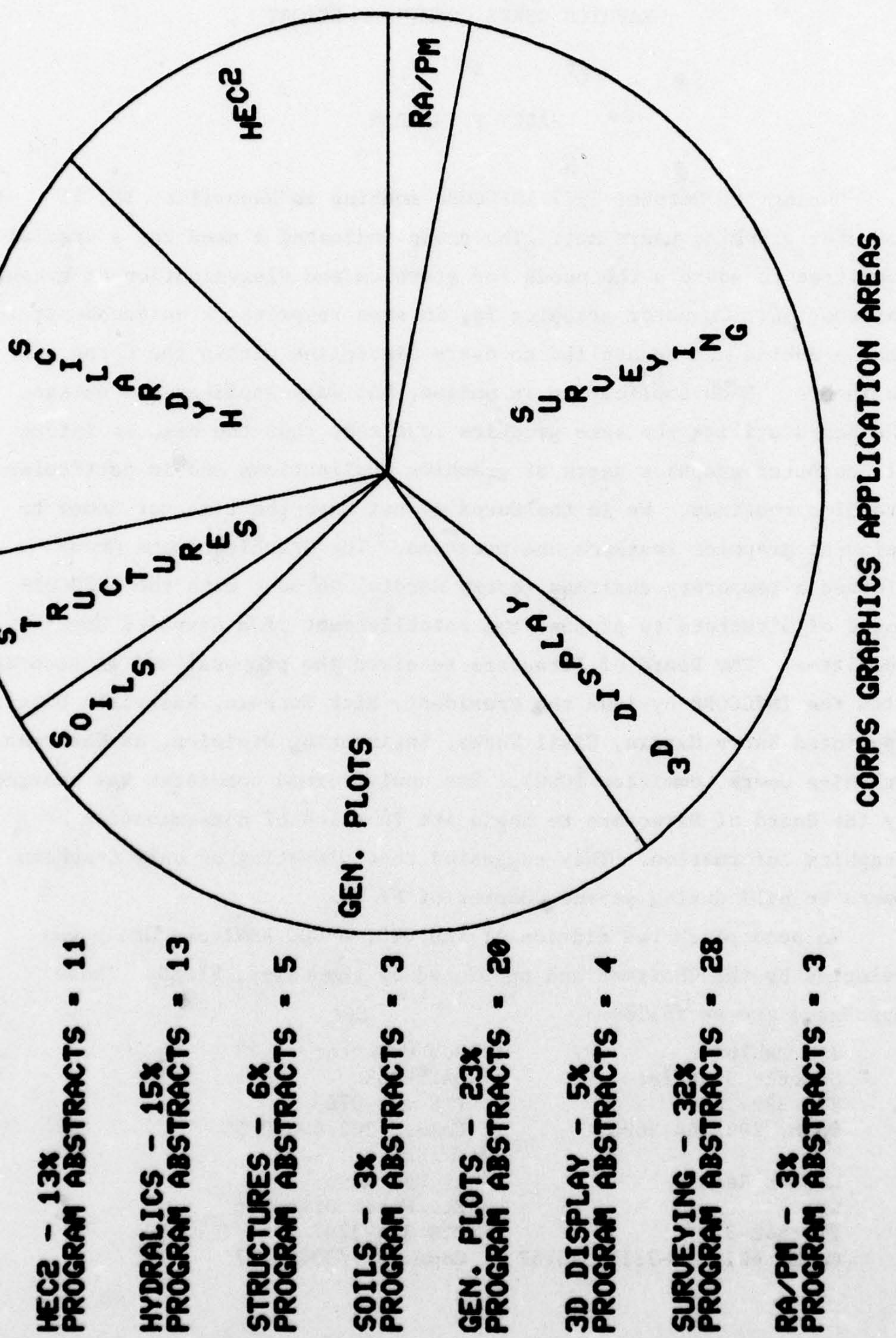
PHIL. - 4%
PROGRAM ABSTRACTS = 3
CORPS OFFICES = 1

OTHER - 3%
PROGRAM ABSTRACTS = 3
CORPS OFFICES = 3

GCS - 24%
PROGRAM ABSTRACTS = 21
CORPS OFFICES = 7



CORPS GRAPHICS SOFTWARE


CORPS GRAPHICS APPLICATION AREAS
HEC2
RA/PM
SURVEYING
3D DISPLAY
GEN. PLOTS
SOILS
STRUCTURES
HYDRALICS
HEC2 - 13%
PROGRAM ABSTRACTS = 11
HYDRALICS - 15%
PROGRAM ABSTRACTS = 13
STRUCTURES - 6%
PROGRAM ABSTRACTS = 5
SOILS - 3%
PROGRAM ABSTRACTS = 3
GEN. PLOTS - 23%
PROGRAM ABSTRACTS = 20
3D DISPLAY - 5%
PROGRAM ABSTRACTS = 4
SURVEYING - 32%
PROGRAM ABSTRACTS = 28
RA/PM - 3%
PROGRAM ABSTRACTS = 3

INFOCORP

GRAPHICS USERS COMMITTEE REPORT

BY

HARRY F. HARDIN

During the October 1977 INFOCORP meeting in Nashville, TN, 55 computer graphics users met. The group indicated a need for a special committee to address the needs for graphics and dissemination of graphics information. Computer graphics is, in some respects, a unique beast in that graphics can be applied to every discipline within the Corps of Engineers. Each application is unique, but many applications across the board utilize the same graphics routines, thus the need to inform all computer graphics users of graphics applications and in particular graphics routines. We in the Corps do not have the time nor money to reinvent graphics routines and programs. The Graphics Users Group elected a temporary chairman (Harry Hardin) to meet with the INFOCORP Board of Directors to propose the establishment of a Graphics Users Committee. The Board of Directors received the proposal and in accordance with the INFOCORP by-laws the President, Rick Conners, Nashville District, appointed Harry Hardin, Civil Works, Engineering Division, as Chairman, Graphics Users Committee (GUC). The newly formed committee was charged by the Board of Directors to begin its function of dissemination of Graphics Information. They suggested that a meeting of only Graphics Users be held during second quarter of FY 78.

To accomplish the mission of the GUC, a GUC Advisory Group was selected by the Chairman and appointed by the Chief, EIDSO. Those appointed are as follows:

Jim Dahlen
Seattle District
FTS 399-3696
Comm. 209/764-3696

Bob McMurrer
DAEN-DSE
FTS 693-0705
Comm. 202/693-0705

Robert Hall
WES
FTS 542-3757
Comm. 601/636-3111, X3757

Al Montalvo
Ft. Worth District
FTS 334-3207
Comm. 817/334-3207

Jim Jones WES FTS 542-3533 Comm. 601/626-3111, X3533	Don Phillips Jacksonville District FTS 946-2461 Comm. 904/791-2461
John Lambrecht Nashville District FTS 852-7138 Comm. 615/251-7138	Ed Stone Huntington District FTS 924-5788 Comm. 304/529-5788
Jim Waller Wilmington District FTS 674-9576 Comm. 919/343-4841	Harry Hardin OCE FTS 693-0570 Comm. 202/693-0570

I have taken the liberty to put their telephone numbers in the report so that you or any computer graphics user can have access to these experts.

The GUC Advisory Group held its first meeting 30 Nov - 2 Dec 77, in OCE. The members were divided into sub-groups to develop a detail plan of action for GUC. The sub-groups were given the following tasks:

a. By-Law and Communication

b. Computer Graphics Colloquium

c. Graphics Standards.

Each sub-group met and formulated recommendations for submission to GUC. These recommendations are as follows:

a. Conduct a graphics colloquium

b. Resurrect EP 18-1-3 and have it on-line with the TSP vendor

c. Appoint an Engineer Computer Notes (ECN) reporter for graphics

d. Forums be held annually on graphics

e. Use the advisory group members as sounding board for any graphics standards to be developed for the Corps.

The status of accomplishment of these recommendations is as follows:

a. Engineering Division of Civil Works was asked to fund and support a graphics colloquium. Approval was obtained and the WES was requested to conduct the colloquium in conjunction with graphics work units funded and supported by the Computation and Analysis Section of Engineering Division, Civil Works. You are attending the colloquium this wee[illegible] (1-3 Aug 78).

b. EIDSO was provided a copy of the recommendations of th[illegible] to update the EP 18-1-3 catalog of programs and to put it on-l[illegible]e with the TSP vendor. Also, the INFOCORP Board of Directors modified the

committees recommendation to include a program brief as well as a one-line listing of the program name. The procedures to accomplish this are being developed by EIDSO.

c. As Chairman of GUC, I have appointed Mr. Robert Hall, WES ADP Center, as Computer Graphics Reporter for the ECN.

d. Nothing has been done officially to set up annual graphics forums. The committee will meet after this colloquium and recommendations for future meetings will be formulated.

e. In December 1977, the GUC Advisory Group attended an OCE briefing on the Graphics Compatability System (GCS). This meeting was sponsored and conducted by Civil Works to provide OCE an indepth review of GCS. At this meeting it was proposed that GCS be accepted as a standard Corps-wide graphics language. The GUC Advisory Group furnished its comments and suggestions as found in the inclosed report (Incl 1). A proposal from the WES to update GCS, with suggested changes made by the GUC Advisory Members, has been submitted and is now being evaluated. The GUC Advisory Members will be consulted for suggestions on the final recommendations.

1 Incl
as

CORPS STANDARD GRAPHICS LANGUAGE REQUIREMENTS

1. MACHINE COMPATIBLE

The Graphics Software System must execute on all computers the Corps uses. The Primary Graphics Software System will be developed to execute on the District computers, with an enhanced version available on larger remote systems.

2. DEVICE COMPATIBLE

The Graphics Software System must permit plots to be displayed on a variety of Graphics Terminals and/or plotters with no (or little) change to the user's program.

3. ANS FORTRAN

The Graphics Software System must be a group of ANS Fortran subroutines.

4. ENHANCEMENTS/MODIFICATIONS

The Graphics Software System must be modular in design to provide easy expansion by both the graphics development activity and/or the using Corps field office.

5. CALCOMP SUPPORT

The Graphics Software System must support all basic Calcomp calls.

6. DOCUMENTATION

There must be extensive comments in the Graphics Software System so that the present devolopers and/or future developers can understand and change the source code of the Software System.

Incl 1

7. "CORE" SUPPORT

Functions that have been defined as fundamental to Graphics Software standardization will be incorporated into the Graphics Software System. These functions have been published by SIGGARAPH* in their proposed "Core" System.

8. STAFFING AND SUPPORT

The Graphics Software System must have adequate staffing and financial support to assure a continuity of the system and to accomplish other support requirements normally provided by a Software Support Activity.

* Special Interest Group on Graphics Of The Association For Computing Machinery

SUPPORT AND IMPLEMENTATION FOR THE CORPS SUPPORTED GRAPHICS LANGUAGE

1. Training
2. Assistance
3. New routines
4. Quick response to field needs
5. User manuals
6. On-Site performance evaluation
7. Implementation guidelines for computer graphics devices
8. Dissemination
9. Software updates
10. Continuity

BY-LAWS AND COMMUNICATIONS SUB-GROUP REPORT

I. Proposed MODIFICATIONS TO INFOCORPS BYLAWS

1. There shall be four permanent committees in Infocorps which are : Bylaws, Applications, User Relations, and Graphics Users.

2. The purposes of the Graphics Users Committee (GUC) are to provide avenues of information exchange in the areas of graphics applications and hardware and to encourage the use of a Corps-supported graphics software system.

   The committee chairman shall be responsible for appointing all committee members. The majority of the members shall be selected from the field offices to ensure that GCS remains responsive to the needs of the Districts.

II. COMMUNICATIONS

1. Recommend resurrection of EP 18-1-3 both as a periodic publication and as an on-line data file on the Corps-wide TSP vendor's system.

2. Forums for information exchange to be held annually. However, no Forum shall be held within 3 months of the regular Infocorp meeting.

3. A GUS committee member shall be tasked with seeking out articles for the Engineering Computer Notes (ECN).

COMPUTER GRAPHICS COLLOQUIUM SUBGROUP REPORT

OBJECTIVE: To further the objectives of the Graphics Users Committee of INFOCORPS by convening delegates from Corps activities who serve as graphics coordinators for their respective activity with the ultimate goal of developing an improved unified computer graphics capability in the Corps.

WHO SHOULD ATTEND: Personnel responsible for direct support of an activities computer-generated graphics.

DISCUSSION: It is the opinion of the Graphics Users Committee that enhancement of computer graphics in the Corps and exchange of graphics information through INFOCORPS can best be achieved through an orginized effort of personnel who would normally be responsible for the direct support of computer graphics. For this reason, the first graphics colloquium should concentrate on the general theme of identifying the various talents and capabilities in computer graphics within the Corps and organizing these talents into a unified effort to improve the Corps computer graphics. This nucleus of computer graphics talent would also serve as a means for the exchange and dissemination of computer graphics applications to the users. The committee considered recommending the presentation of graphics applications in a separate graphics interest session (possibly concurrent with other functional activity session) during the general INFOCORPS meeting. They discarded this idea in favor of the present practice of presenting computer applications (to include computer graphics) within the framwork of concurrent sessions according to functional activity. To foster the "Joint Graphics Develop-

ment" theme and to assure the colloquium contains topics of general interest the committee suggests WES develop a simple informative questionnaire soliciting the field to identify their interest in discussion topics under consideration and comment on other possible topics. The questionnaire should also request field activities to identify and describe some (or all) of their graphic efforts to include such information as:

A. Number of program

B. Program name

C. Host system

D. Brief description of program

E. Language

F. Graphic language

H. Relationship to other programs

I. Indicate who might attend the Colloquium and could be contacted for further information

J. What graphics equipment do you presently have

K. What graphics topics are you interested in

L. What further graphics applications do you foresee a need for.

The final agenda for the colloquium could then be developed based on the response of these questionnaires. NOTE: A comprehensive summary of the field response to the questionnaires should be prepared (identifying contributors) and be made a part of the Colloquium Summary Report.

DURATION: The committee recommends the length of the Colloquium not exceed 2 to 2-1/2 days, depending on the topics to be covered and that the times for convening and concluding the Colloquium be planned to facilitate arrival and departure times of the participants (particularly those coming from the West Coast).

DATES: The period of April-May was suggested as a reasonable period to convene the Colloquium with the exact dates to be recommended by the host site (WES).

SPECIAL INVITATIONS: The committee suggests special invitations be sent to ETL, HEC, and non-Corps activities having interests in computer graphics such as TVA, USGS, Bureau of Reclamation, Federal Highway Authority, etc.

POTENTIAL TOPICS FOR DISCUSSION:

1. Recommendation for distributing information on graphics activities in the Corps.
2. Types of graphics now being performed in the Corps.
3. Discussion of graphic potential in the Corps.
4. Equipment needs for effective graphics.
5. Other graphics interest groups.
6. Use of floppy disk to distribute application activities.
7. Documentation of graphics.
8. Demonstration of graphics packages.
9. Graphics equipment in the Corps.
10. Host systems used by Corps activities for graphics.
11. Recommendations for further Colloquiums.
12. Should the Corps adopt a standard graphics language? What should it include? What guidelines should be provided to graphics support?

13. Summary report of INFOCORP Graphics User's Committee.

14. Discussion of different graphics package and advantages and disadvantages of each.

15. Separate sessions for graphics in support of specific functions (Hydraulics Structures, Survey, etc.).

RECOMMENDED CHAIRMAN: The committee suggests the Colloquium be chaired by person from a District activity having an extensive understanding of graphics applications and recommends the name of Bob Brittain be considered. He was contacted and indicated he would serve as chairman.

SOFTWARE

C A L C O M P   G R A P H I C S

PRESENTATION BY:

Edward A. Stone
U. S. Army Engineer District, Huntington

COMPUTER GRAPHICS COLLOQUIUM

Waterways Experiment Station

Vicksburg, Mississippi

1-3 August 1978

C A L C O M P   G R A P H I C S

INDEX

* CALCOMP MAN

CALCOMP SOFTWARE

CALCOMP provides graphic software in three general categories:

* BASIC SOFTWARE

  FUNCTIONAL SOFTWARE

  APPLICATIONS PROGRAMS

* PLOT — Plot straight line between two points; establish plot origin; generate search addresses. Also contains four entry points for auxiliary functions:

  PLOTS - Initialization

  FACTORS - Scale entire plot

  WHERE - Returns current pen location

  NEWPEN - Selects pen

  SYMBOL — Plots annotation and special symbols.

  NUMBER — Plots the decimal equivalent of an internal floating point number.

  SCALE — Determines starting value and scale for an array of data to be plotted on a graph.

  AXIS — Draws an annotated axis line for a graph.

  LINE — Scales and plots a set of data points defined by X and Y coordinate arrays.

The lowest level of software used in producing a plot is termed Basic Software. Depending upon the plotting system, basic software may be supplied only for the host computer or for both the host computer and the controller. The controller basic software is the operating software for the controller and is normally of little concern to the

programmer. Host Computer Basic Software (HCBS) consists of a set of subroutines which allow the programmer to perform elementary plotting operations such as drawing lines or annotation, selecting a pen, scaling the plot, etc. The basic software generates the commands necessary to perform the specified operation and transmits them to the plotter if it is on-line, or writes the commands on an appropriate medium (e.g. magnetic tape) for subsequent plotting off-line.

The plot commands generated by the basic software may be the actual codes necessary to move the plotter, but usually they are codes which represent the input data in a highly compact and efficient format. These codes are then interpreted by hardware (in some systems) but normally by software (on a CalComp controller) which then produces the actual codes necessary to drive the plotter.

DIMENSION XARRAY (26), YARRAY (26)
Reserve space for 24 data values plus two additional locations required by the SCALE, AXIS, and LINE subroutines.

10 CALL PLOTS (0, 0, 6)
Initialize the PLOT subroutine with the logical number of the output device.

20 READ 25, (XARRAY (I), YARRAY (I), I = 1, 24)

25 FORMAT (2F6.2)
Read 24 pairs of TIME and VOLTAGE from an input file into two arrays with names XARRAY and YARRAY.

30 CALL PLOT (0.0, 0.5, -3)
Establish a new origin one-half inch higher than the point where the pen was initially placed by the operator so that the annotation of the TIME axis will fit between the axis and the edge of the plotting surface.

40 CALL SCALE (XARRAY, 5.0, 24, 1)
Compute scale factors for use in plotting the TIME values within a five-inch plotting area.

50 CALL SCALE (YARRAY, 6.0, 24, 1)
Compute scale factors for use in plotting the VOLTAGE data values within a six-inch plotting area (i.e., the data pairs of TIME, VOLTAGE will plot within a five-by-six-inch area).

60 CALL AXIS (0.0, 0.0, 20HTIME IN MILLISECONDS, -20, 5.0, 0.0, XARRAY (25), XARRAY (26))
Draw the TIME axis (5 inches long), using the scale factors computed in statement 40 to determine the milliseconds at each inch along the TIME axis.

70 CALL AXIS (0.0, 0.0, 7HVOLTAGE, 7, 6.0, 90.0, YARRAY (25), YARRAY (26))
Draw the VOLTAGE axis (6 inches long), using the scale factors computed in statement 50 to determine the voltage at each inch along the VOLTAGE axis.

80 CALL LINE (XARRAY, YARRAY, 24, 1, 2, 4)
Plot VOLTAGE vs TIME, drawing a line between each of the 24 scaled points and a symbol X at every other point.

90 CALL SYMBOL (0.5, 5.6, 0.21, 16HPERFORMANCE TEST, 0.0, 16)
Plot the first line of the graph title.

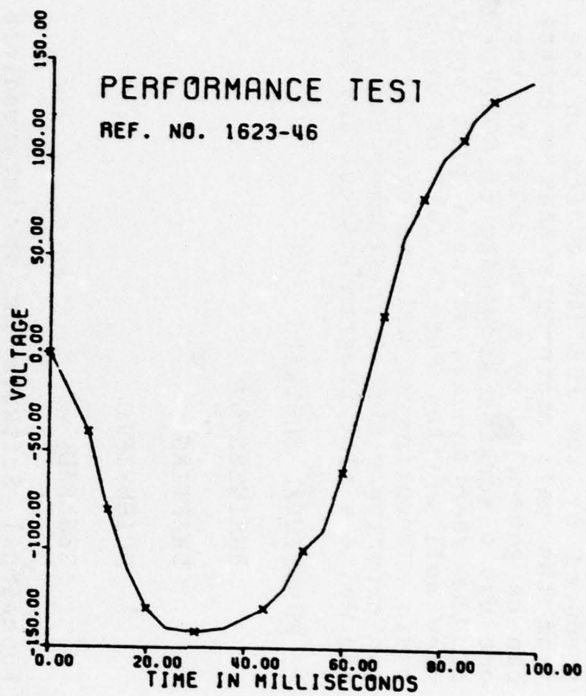
100 CALL SYMBOL (0.5, 5.2, 0.14, 16HREF. NO. 1623-46, 0.0, 16)
Plot the second line of the graph title.

110 CALL PLOT (12.0, 0.0, 999)
Advance the pen beyond the current plotting area, write a terminating record, and close the plot output device.

120 STOP
Terminate program execution.

END

A SAMPLE PLOTTING PROGRAM



To illustrate the use of CALCOMP Host Computer Basic Software let's look at an example. The Plot on the right is produced by the FORTRAN coding on the left. You can see from the call statements that a pretty sophisticated plot can be generated by a few calls to the basic software. If one has a working knowledge of FORTRAN he can, with the aid of the user manual, write a plot program. The manual is very well written and is full of examples of calls to the basic subroutine as well as examples of plots. It has been our experience that a programmer can sit down with he manual and write a plot program without any assistance.

* FUNCTIONAL SOFTWARE

BUSINESS

DRAFTING

SCIENTIFIC

GENERAL

Functional Software is an intermediate level of software which relieves the user of programming many commonly used graphic functions. Functional Software is further subdivided into host-computer resident and controller-resident type software. Host-computer resident functional software is usually written in FORTRAN and grouped into packages by general application:

Let's look at the Business Functional Software.

* BUSINESS CATEGORY

AXISB	Draws an axis with "business" annotation.
AXISC	Draws an axis with calendar month annotation.
BAR	Draws bars, for bar graph plotting.
LBAXS	Draws a logarithmic axis with business annotation.
LGLIN	Plots data in either log-log or semi-log mode.
SHADE	Draws shading between lines.
SCALG	Performs scaling for logarithmic plotting.

* Read above as you show slides

The next category is the Drafting Functional Software.

* DRAFTING CATEGORY

AROHD	Draws various types of arrowheads.
ARROW	Draws a line terminated with an arrowhead through a set of data points.
CNTRL	Draws a "center line" through a set of data points.
DIMEN	Draws annotated dimension lines with extension lines.
LABEL	Draws annotation centered between two points with control over symbol placement.

\# Read above as you show slides (15-19)

The next category is Scientific Functional Software.

* SCIENTIFIC CATEGORY

CURVX	Plots a function of X over a given range.
CURVY	Plots a function of Y over a given range.
FLINE	Draws a smooth curve through a set of data points.
LGAXS	Draws a logarithmic axis with annotation.
LGLIN	Plots data in either log-log or semi-log mode.
POLAR	Plots data points using polar coordinates.
SCALG	Performs scaling for logarithmic plotting.
SMOOT	Draws a smooth curve through sequential data points.

\# Read above as you show slides (21-29)
2 slides on CURVX
2 slides on CURVY
2 slides on FLINE
SCALG and LGLIN were shown in earlier slides

The next category is the General Functional Software.

* GENERAL CATEGORY

CIRCLE	Draws a circle or spiral.
DASHL	Draws dashed lines connecting a series of data points.
DASHP	Draws a dashed line to a specified point.
ELIPS	Draws an ellipse or elliptical arc.
FIT	Draws a curve through three points.
GRID	Draws a linear grid.
POLY	Draws an equilateral polygon.
RECT	Draws a rectangle.

Read above as you show slides (31-38)

The final category of the Functional Software is the Miscellaneous.

* MISCELLANEOUS CATEGORY

CVPLT	Polynomial Curve Fitting Routine, accompanied by a driver to allow use as a complete program, which determines and plots a polynomial of given degree which best fits the data points. The least squares approximation technique is used. Data points also are plotted.
FLOCT	Flowchart production program which plots and annotates a flowchart defined by input data cards.
FORGN	Tape and Card Forms Generator which draws the blank form with headings, for tape formats or card forms, as defined by input data cards.

I don't have a slide of the CVPLT.

The final category of CALCOMP Software is the Application Software.

The highest level of graphic software is the Applications Program. An Application Program is a complete problem solver. A user need only supply data and select among program options to obtain the desired graphical output - no programming is required on the user's part. Applications Program are written in a higher level language, usually FORTRAN IV, and are available for a variety of computers.

* THREE-D - A PERSPECTIVE DRAWING PROGRAM

THREE-D Plots three dimensional and perspective views of a function of two independent variables. Will automatically grid and smooth data, draw and annotate axes.

THREE-D automatically draws three-dimensional perspective representations of any data that can be expressed as a single-valued function of two variables. Surfaces may be drawn as transparent (all lines showing) or opaque (hidden lines removed). Typical applications include representation of terrain, pressure or heat distribution over a surface, mathematical formulas, and demographic data. Stereo pairs may also be generated.

All of the above features are incorporated into THREE-D I. In addition, THREE-D II can grid irregularly spaced data, smooth a rough array, and perspectively annotate the X-Y-Z axes.

* GPCP - A GENERAL PURPOSE CONTOURING PROGRAM

GPCP   A General Purpose Contouring Program to plot contour maps under control of a variety of options.

Put up slide of coal seam & RDB rock

GPCP is an extremely accurate program used to produce contour maps. The program uses a unique gridding algorithm to construct an analytically smooth surface from random data values, and has been used in a wide variety of applications with seismic, demographic, geological, thermal, and pressure data. The user can arbitrarily delete contour lines in desired areas, plot bold index contours with or without labels, annotate the map with symbols and lines, save the calculated grid mesh point values, and input known gradients to assist the gridding algorithm.

GPCP I requires that all data fit in core to produce a map. GPCP II uses data-partitioning methods to segment the data so that the size of the map is not limited to core. In addition to ssaving the grid mesh point values, GPCP II permits the user to save the raw data points and the computed surface tangent values.

Both versions of the program are available with extra-cost options. These options include grid-to-grid operations (add, divide, compare, etc.), integration for surface area and volume, profiling (surface cross-sections), trend surface analysis, and additional data posting methods.

* FLOWGEN/F - A FORTRAN FLOWCHART GENERATOR

FLOWGEN   A program which automatically produces and plots a flowchart of any ANS FORTRAN IV program directly from the source desk.

Sample flowchart slide

FLOWGEN/F enables users to input FORTRAN source and obtain a fully annotated flowchart of the routine formatted to fit on 8-1/2 x 11 sheets. The program is designed to simplify and standardize the task of program documentation. FLOWGEN/F eases the burden of program debugging, maintenance, and modification. The program analyzes unfulfilled references, numbers each page, and provides off-page references at both source and destination elements.

* AUTONET Enables users to generate Critical Path Method (CPM) linear network charts from the output of any CPM computer program which supplies the necessary I-node/J-node data.

* Sample autonet slide

AUTONET - An Automatic Network Display Program

CalComp's AUTONET programs automatically produce network analysis charts from the output of PERT, CPM, PMS, and other scheduling programs. There are three versions of AUTONET.

AUTONET I produces single-page CPM charts utilizing numbered event rectangles, annotated activity lines, and a linear time scale having calendar dates and elapsed time noted at the top and bottom of the chart.

AUTONET II plots event-oriented as well as activity-oriented charts using a linear time scale. When a chart has more levels than can fit on a plotter page, the overflow will be placed onto another page. Time scales between pages will be consistent.

AUTONET III can handle activity-oriented, event-oriented, or combined activity-event-oriented networks. The number of activities is not limited by core. Sufficient peripheral file space can make the number essentially unlimited.

AUTONET III can plot using a linear time scale or flexible time scale with time-phased (date oriented) or nontime phased (logical relationship) placement of nodes. Networks can be plotted on expected completion date, or latest allowable completion date with the critical path determined by the program or specified by the user.

Activities can be grouped via any user-specified activity/data item such as department or function, and events can be flagged as scheduled or completed. The program has complete X and Y paging capabilities including off-page referencing. Portions of a network may be shown via a user-specified time interval or range within the activity grouping item.

Some additional application packages.

* SAMPS — Creates subdivision maps complete with bearings and distances and calculates lot areas.

  DATAGRAPH — Produces management information charts and graphs directly from user data on cards, tape or disc.

  PROVE — A program which produces verification plots of APT/ADAPT cutter location files for numerically controlled (NC) machine tools.

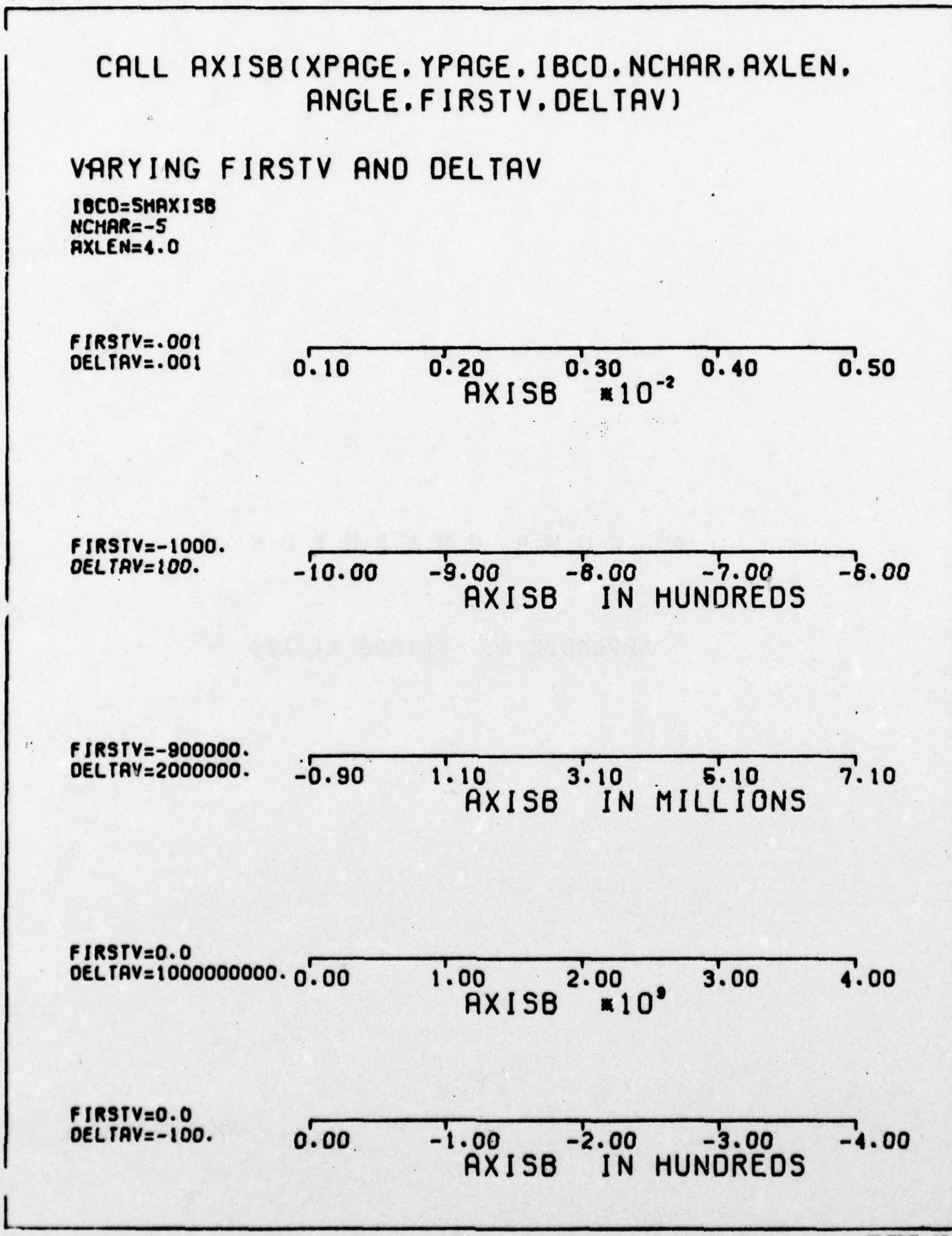
  SYMTRAN — A free-format card input language that allows the user to generate several types of diagrammatic drawings (electrical, electronic, hydraulic, etc.) by specifying symbol placement, interconnections, and annotation.

  A.S.A.P. — Automated Symbolic Artwork Program that processes digitized data to create a disc file that can be edited and plotted. Special symbol menus are tailored to individual application areas and general menu features allow easy, efficient digitizing.

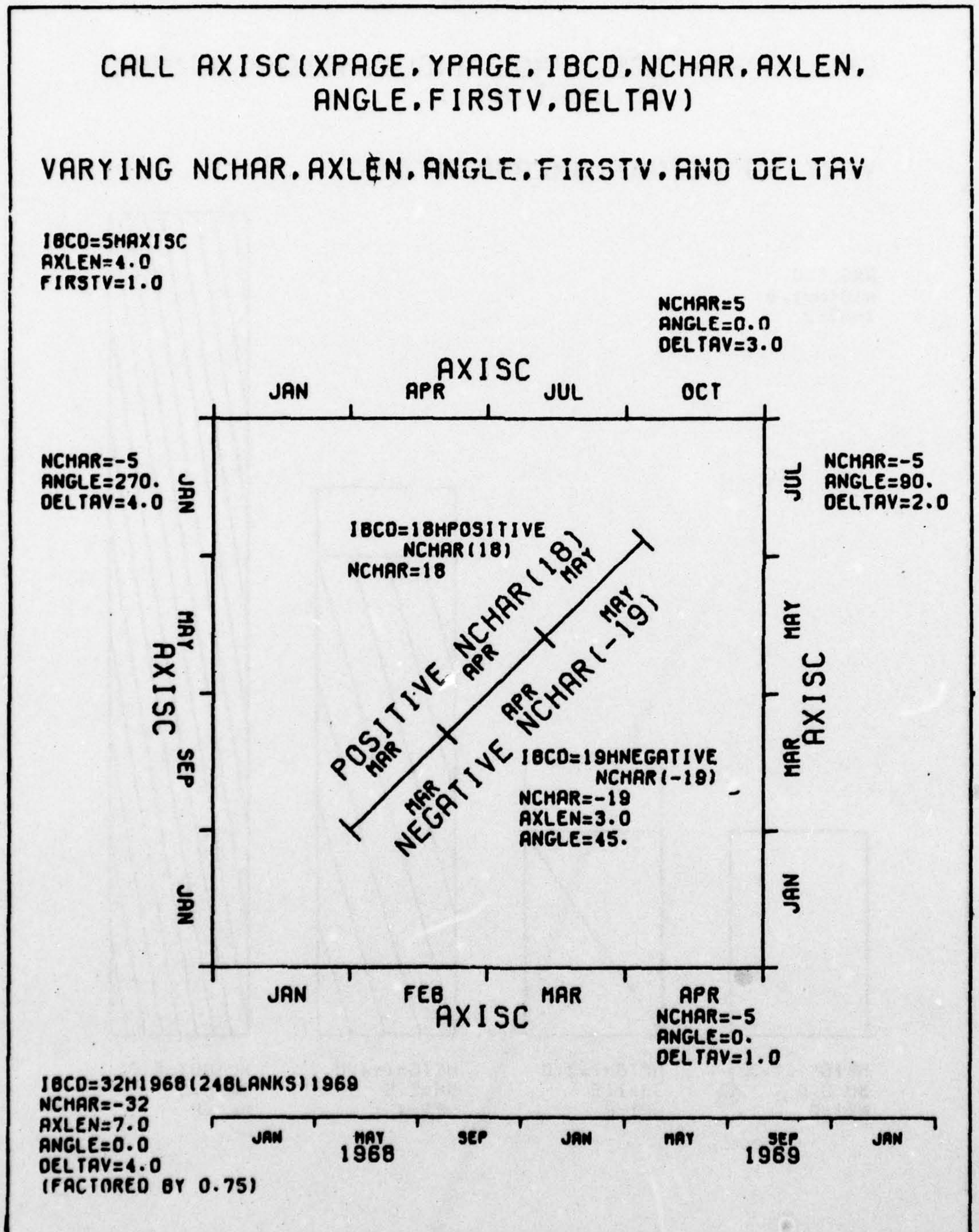
The last thing I have is a hodge podge of miscellaneous slides. Everything that you have seen here is available through your CAA Comp Representative. Any questions?

C A L C O M P   G R A P H I C S

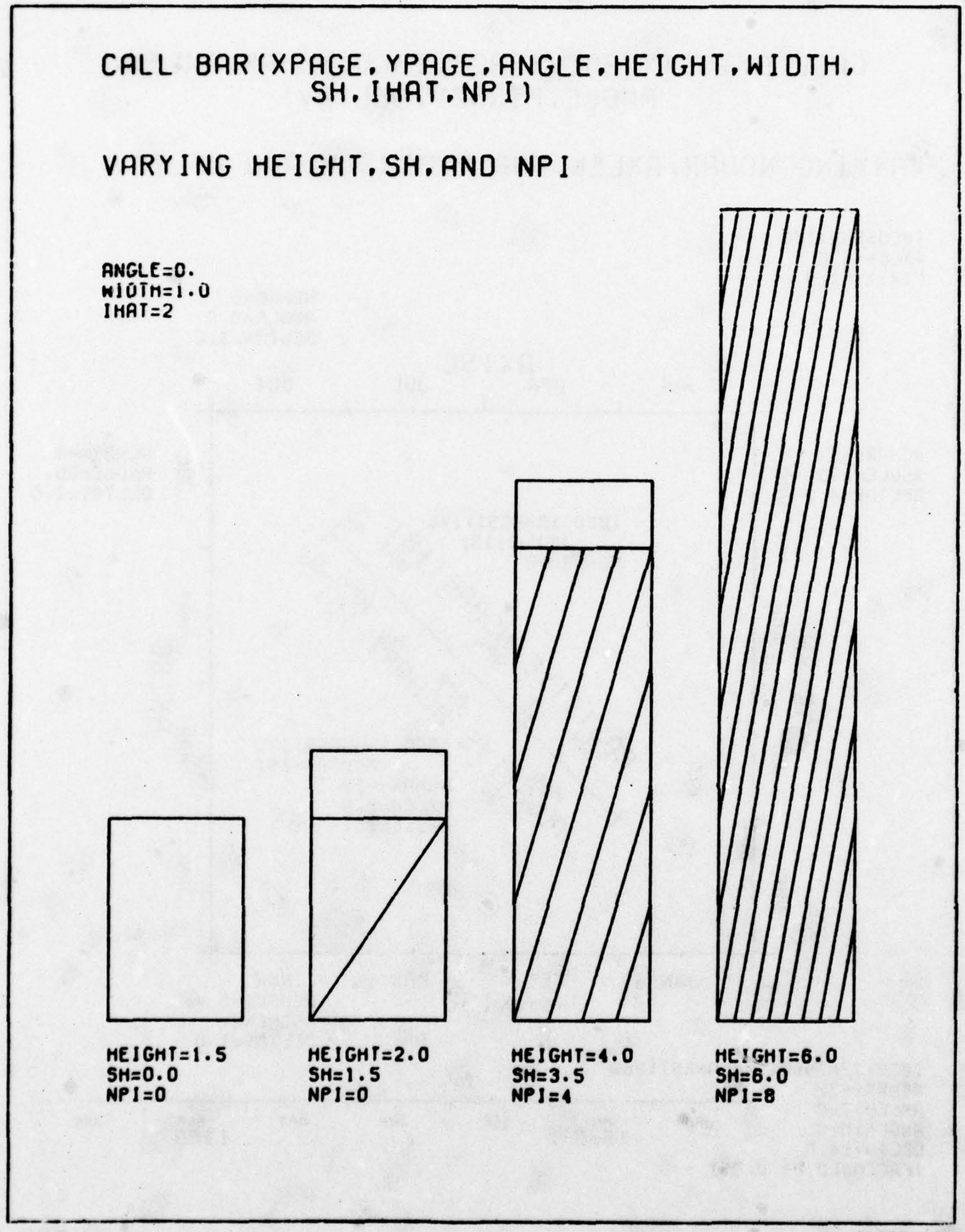
APPENDIX A: SLIDES A1-A29


CALL AXISB(XPAGE,YPAGE,IBCD,NCHAR,AXLEN,
ANGLE,FIRSTV,DELTAV)
VARYING FIRSTV AND DELTAV
IBCD=5HAXISB
NCHAR=-5
AXLEN=4.0
FIRSTV=.001
DELTAV=.001
0.10 0.20 0.30 0.40 0.50
AXISB *10⁻²
FIRSTV=-1000.
DELTAV=100.
-10.00 -9.00 -8.00 -7.00 -6.00
AXISB IN HUNDREDS
FIRSTV=-900000.
DELTAV=2000000.
-0.90 1.10 3.10 5.10 7.10
AXISB IN MILLIONS
FIRSTV=0.0
DELTAV=1000000000.
0.00 1.00 2.00 3.00 4.00
AXISB *10⁹
FIRSTV=0.0
DELTAV=-100.
0.00 -1.00 -2.00 -3.00 -4.00
AXISB IN HUNDREDS

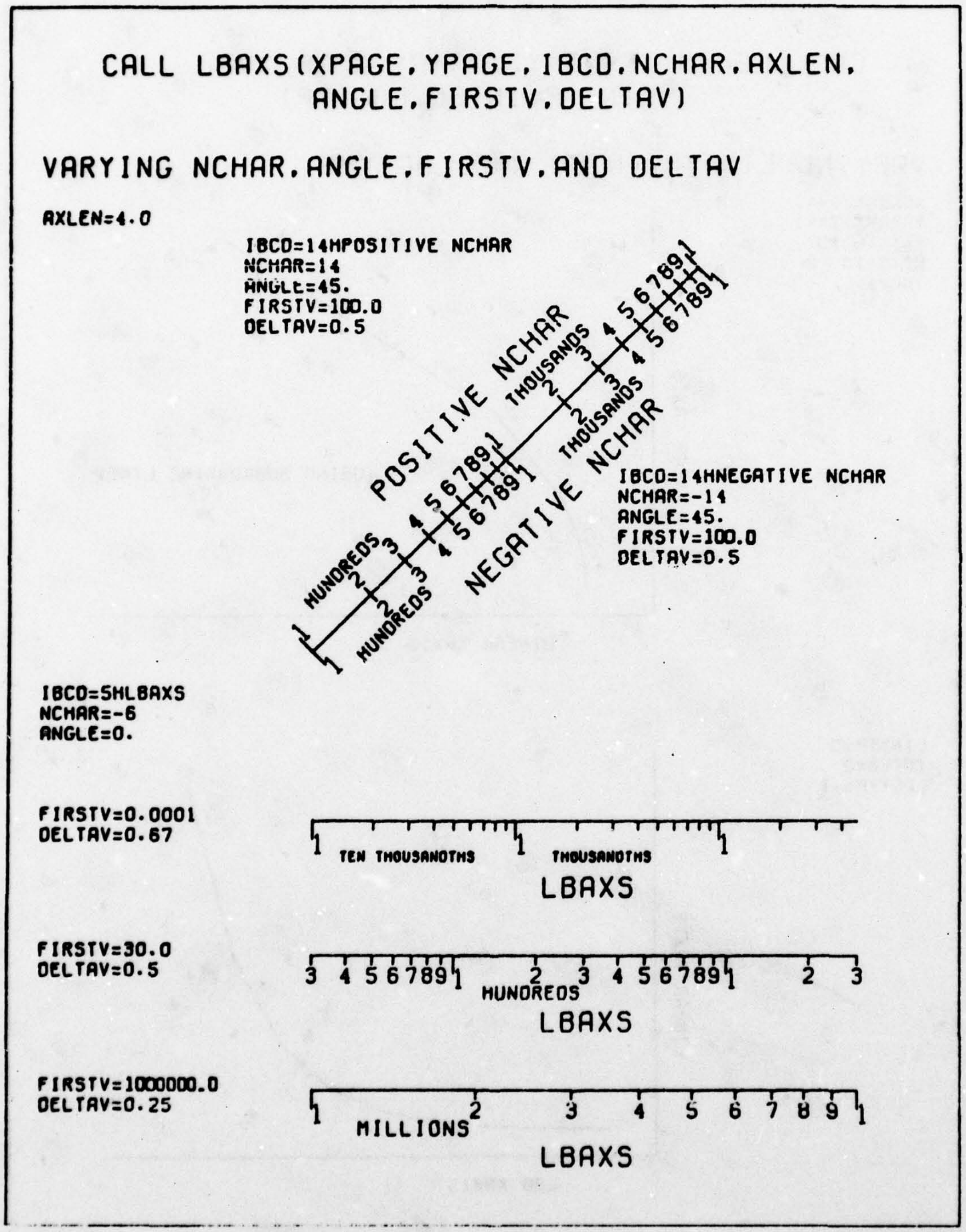
SLIDE A1


CALL AXISC(XPAGE,YPAGE,IBCD,NCHAR,AXLEN,
ANGLE,FIRSTV,DELTAV)
VARYING NCHAR,AXLEN,ANGLE,FIRSTV,AND DELTAV
IBCD=5HAXISC
AXLEN=4.0
FIRSTV=1.0
NCHAR=5
ANGLE=0.0
DELTAV=3.0
AXISC
JAN
APR
JUL
OCT
NCHAR=-5
ANGLE=270.
DELTAV=4.0
JAN
MAY
SEP
JAN
AXISC
NCHAR=-5
ANGLE=90.
DELTAV=2.0
JUL
MAY
MAR
JAN
AXISC
IBCD=18HPOSITIVE
NCHAR(18)
NCHAR=18
POSITIVE NCHAR(18)
MAR
APR
MAY
NEGATIVE NCHAR(-19)
IBCD=19HNEGATIVE
NCHAR(-19)
NCHAR=-19
AXLEN=3.0
ANGLE=45.
JAN
FEB
MAR
APR
AXISC
NCHAR=-5
ANGLE=0.
DELTAV=1.0
IBCD=32H1968(24BLANKS)1969
NCHAR=-32
AXLEN=7.0
ANGLE=0.0
DELTAV=4.0
(FACTORED BY 0.75)
JAN
MAY
1968
SEP
JAN
MAY
SEP
1969
JAN

SLIDE A2


CALL BAR(XPAGE,YPAGE,ANGLE,HEIGHT,WIDTH,
SH,IHAT,NPI)
VARYING HEIGHT,SH,AND NPI
ANGLE=0.
WIDTH=1.0
IHAT=2
HEIGHT=1.5
SH=0.0
NPI=0
HEIGHT=2.0
SH=1.5
NPI=0
HEIGHT=4.0
SH=3.5
NPI=4
HEIGHT=6.0
SH=6.0
NPI=8

SLIDE A3

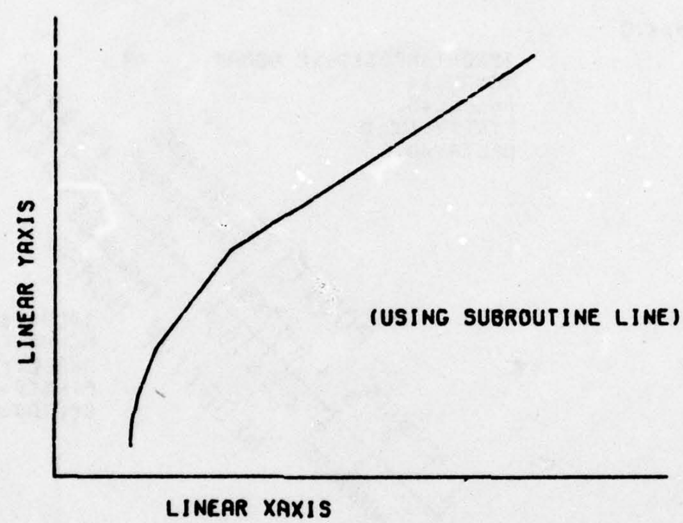

CALL LBAXS(XPAGE,YPAGE,IBCD,NCHAR,AXLEN,
ANGLE,FIRSTV,DELTAV)
VARYING NCHAR,ANGLE,FIRSTV,AND DELTAV
AXLEN=4.0
IBCD=14HPOSITIVE NCHAR
NCHAR=14
ANGLE=45.
FIRSTV=100.0
DELTAV=0.5
POSITIVE NCHAR
HUNDREDS
THOUSANDS
NEGATIVE NCHAR
IBCD=14HNEGATIVE NCHAR
NCHAR=-14
ANGLE=45.
FIRSTV=100.0
DELTAV=0.5
IBCD=5HLBAXS
NCHAR=-6
ANGLE=0.
FIRSTV=0.0001
DELTAV=0.67
TEN THOUSANDTHS
THOUSANDTHS
LBAXS
FIRSTV=30.0
DELTAV=0.5
HUNDREDS
LBAXS
FIRSTV=1000000.0
DELTAV=0.25
MILLIONS
LBAXS

SLIDE A4

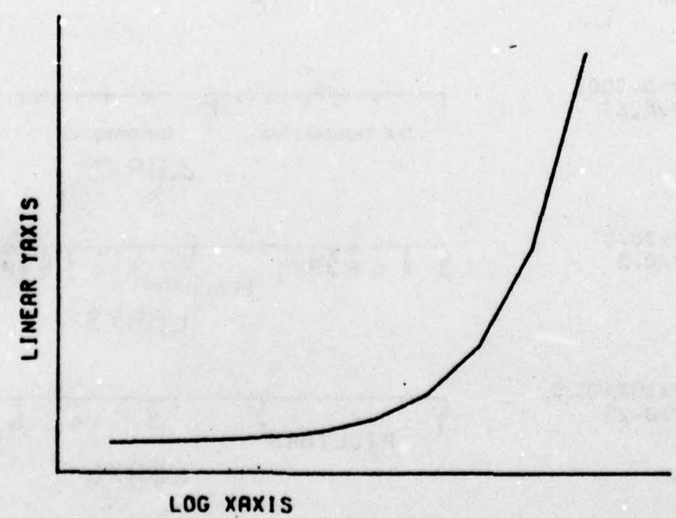
CALL LGLIN (XARRAY, YARRAY, NPTS, INC,
LINTYP, INTEQ, LOGTYP)

VARYING LINTYP, INTEQ, AND LOGTYP

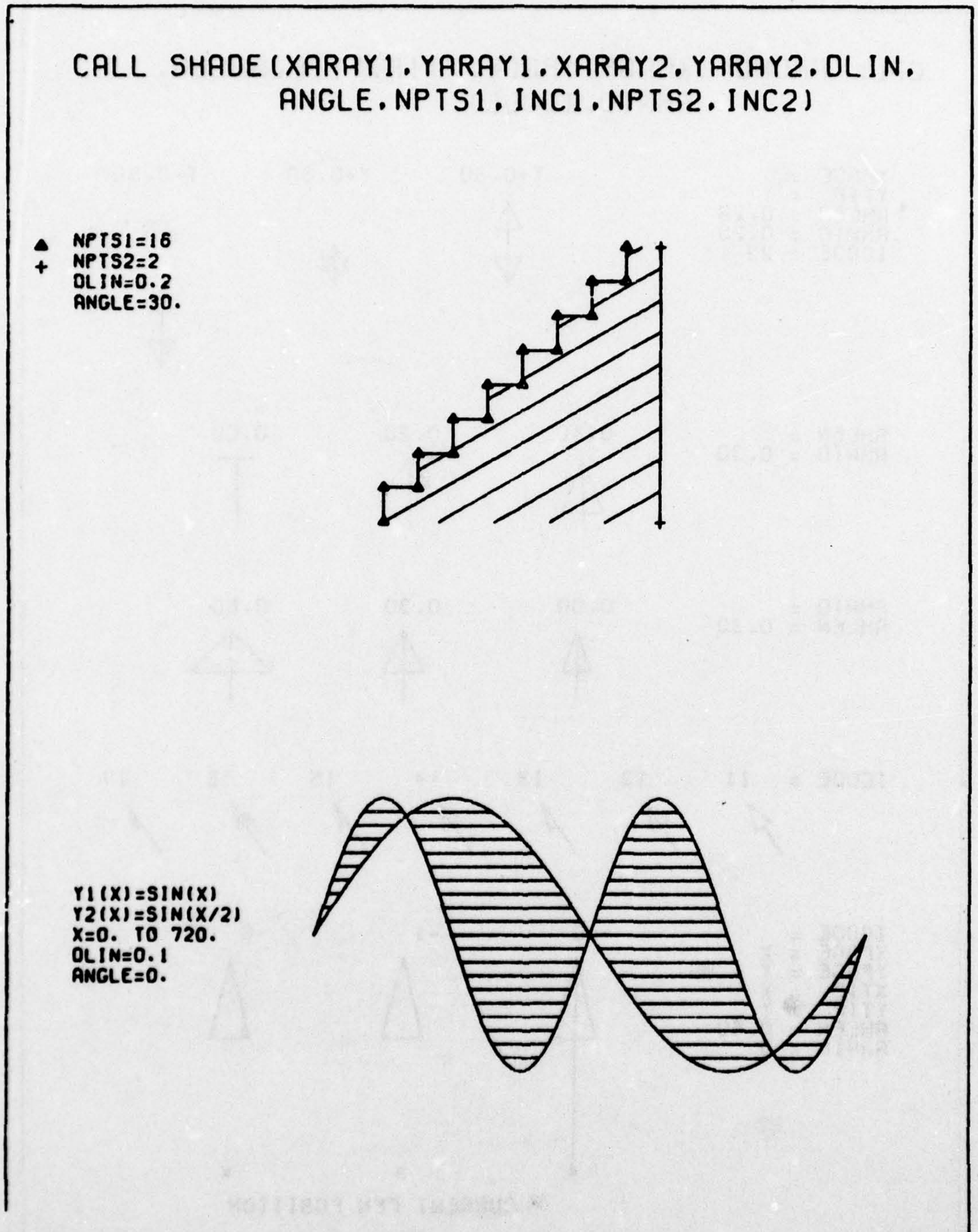
XARRAY=4**I
YARRAY=2**I
I=1 TO 10
NPTS=10
INC=1



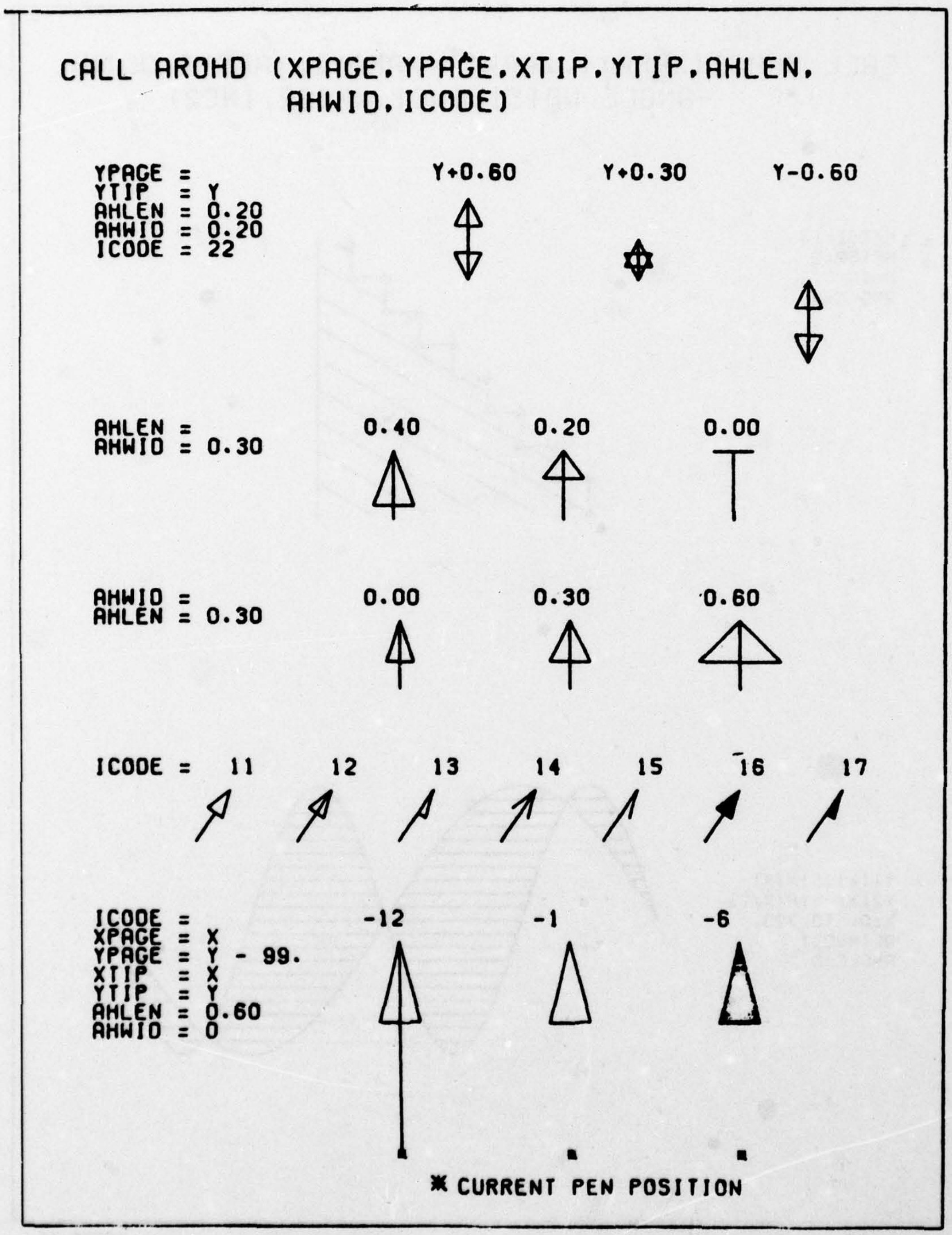
LINTYP=0
INTEQ=2
LOGTYP=-1



SLIDE A5

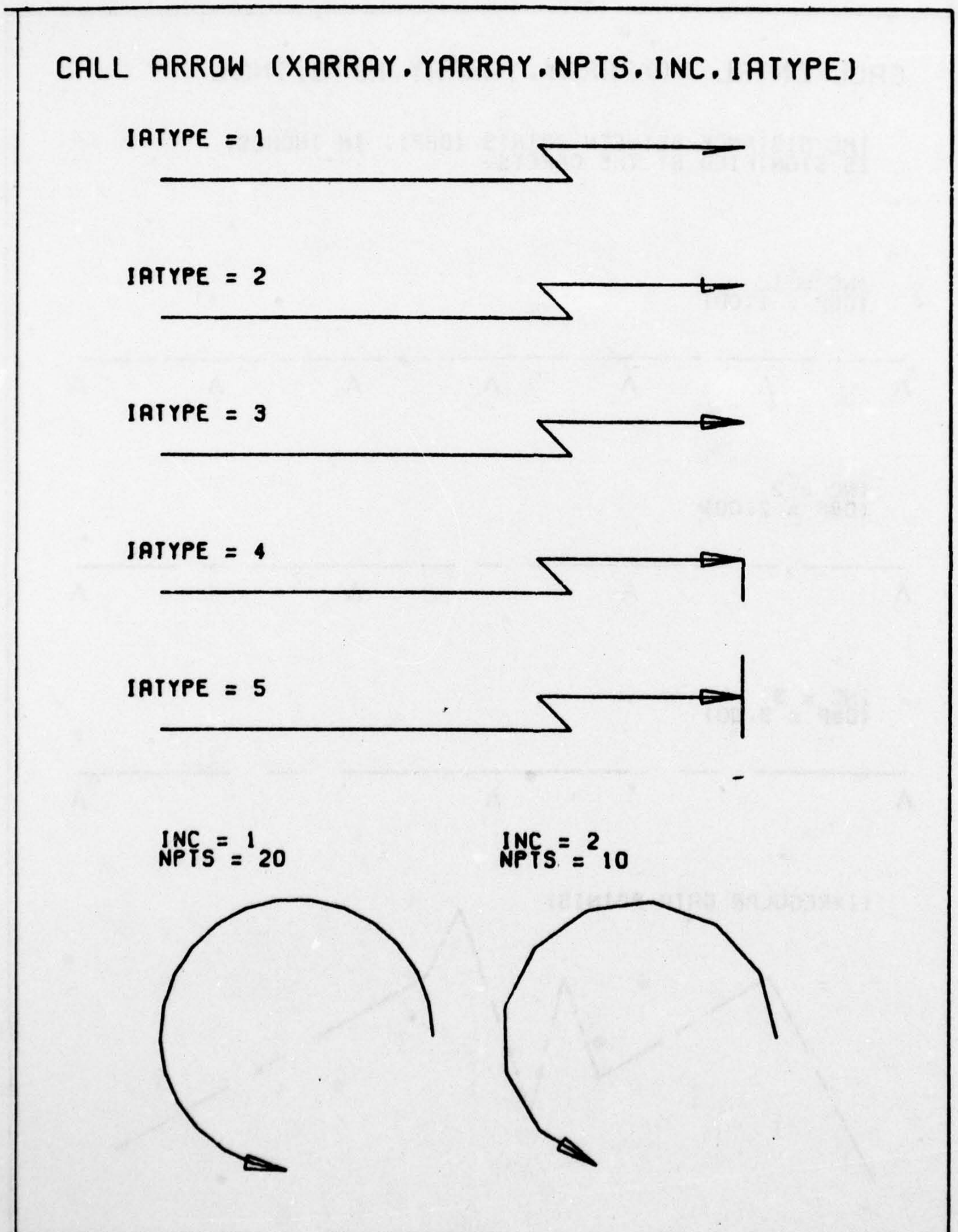

CALL SHADE(XARAY1,YARAY1,XARAY2,YARAY2,DLIN,
ANGLE,NPTS1,INC1,NPTS2,INC2)
▲ NPTS1=16
+ NPTS2=2
DLIN=0.2
ANGLE=30.
Y1(X)=SIN(X)
Y2(X)=SIN(X/2)
X=0. TO 720.
DLIN=0.1
ANGLE=0.

SLIDE A6



CALL AROHD (XPAGE,YPAGE,XTIP,YTIP,AHLEN,
AHWID,ICODE)
YPAGE =
YTIP = Y
AHLEN = 0.20
AHWID = 0.20
ICODE = 22
Y+0.60
Y+0.30
Y-0.60
AHLEN =
AHWID = 0.30
0.40
0.20
0.00
AHWID =
AHLEN = 0.30
0.00
0.30
0.60
ICODE = 11 12 13 14 15 16 17
ICODE =
XPAGE = X
YPAGE = Y - 99.
XTIP = X
YTIP = Y
AHLEN = 0.60
AHWID = 0
-12
-1
-6
* CURRENT PEN POSITION

SLIDE A7

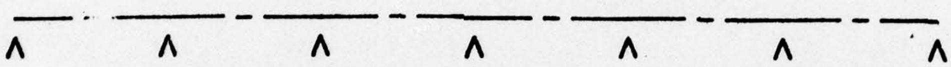

CALL ARROW (XARRAY,YARRAY,NPTS,INC,IATYPE)
IATYPE = 1
IATYPE = 2
IATYPE = 3
IATYPE = 4
IATYPE = 5
INC = 1
NPTS = 20
INC = 2
NPTS = 10

SLIDE A8

CALL CNTRL (XARRAY, YARRAY, NPTS, INC)

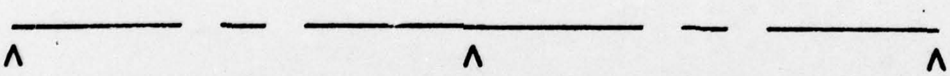
THE DISTANCE BETWEEN POINTS (DBP), IN INCHES, IS SIGNIFIED BY THE CARETS.

INC = 1
(DBP = 1.00)

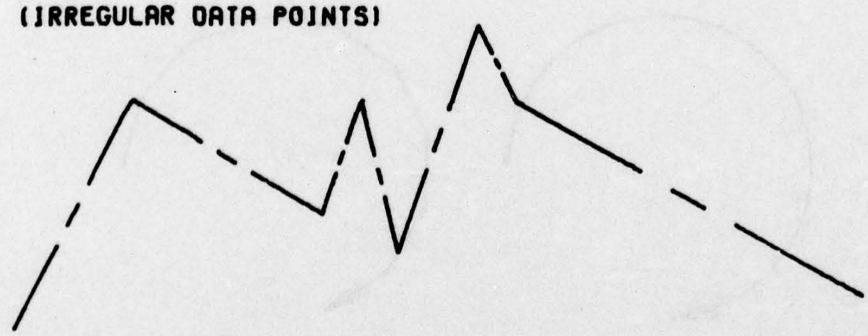


INC = 2
(DBP = 2.00)

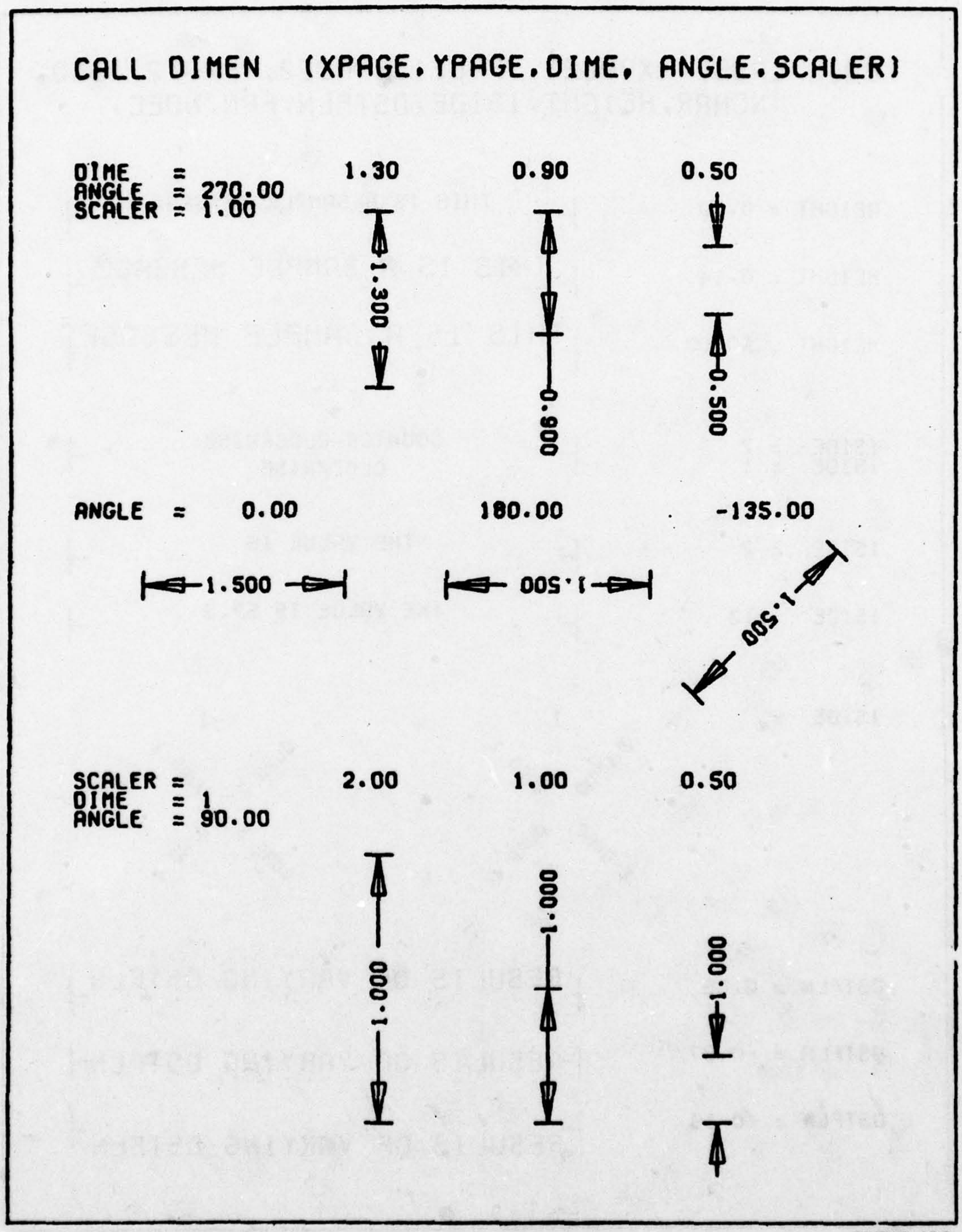
INC = 3
(DBP = 3.00)



(IRREGULAR DATA POINTS)



SLIDE A9


CALL DIMEN (XPAGE,YPAGE,DIME, ANGLE,SCALER)
DIME =
ANGLE = 270.00
SCALER = 1.00
1.30
0.90
0.50
1.300
0.900
0.500
ANGLE = 0.00
180.00
-135.00
1.500
1.500
1.500
SCALER =
DIME = 1
ANGLE = 90.00
2.00
1.00
0.50
1.000
1.000
1.000

SLIDE A10

CALL LABEL (XPAGE1,YPAGE1;XPAGE2,YPAGE2,IBCD,
NCHAR,HEIGHT,ISIDE,DSTFLN,FPN,NDEC)

HEIGHT = 0.10 THIS IS A SAMPLE MESSAGE

HEIGHT = 0.14 THIS IS A SAMPLE MESSAGE

HEIGHT = 90.00 THIS IS A SAMPLE MESSAGE

ISIDE = 2 COUNTER-CLOCKWISE
ISIDE = 1 CLOCKWISE

ISIDE = 2 THE VALUE IS

ISIDE = 12 THE VALUE IS 57.3

ISIDE = 1 -1

DSTFLN = 0.05 RESULTS OF VARYING DSTFLN

DSTFLN = -0.07 RESULTS OF VARYING DSTFLN

DSTFLN = -0.19 RESULTS OF VARYING DSTFLN

SLIDE A11

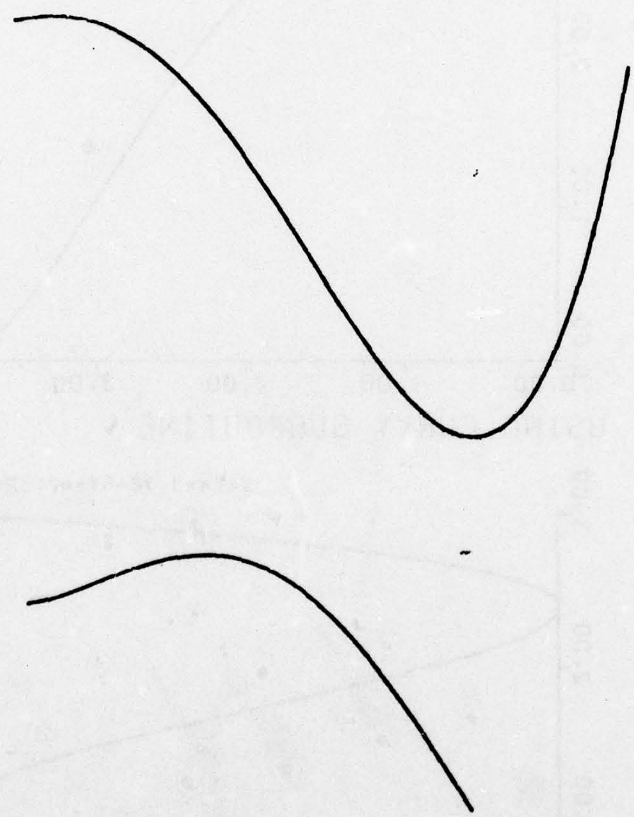
```
CALL CURVX(XO,XF,COEFF1,EXP1,COEFF2,
           EXP2,COEFF3,EXP3,COEFF4,EXP4)
```

VARYING XO AND XF

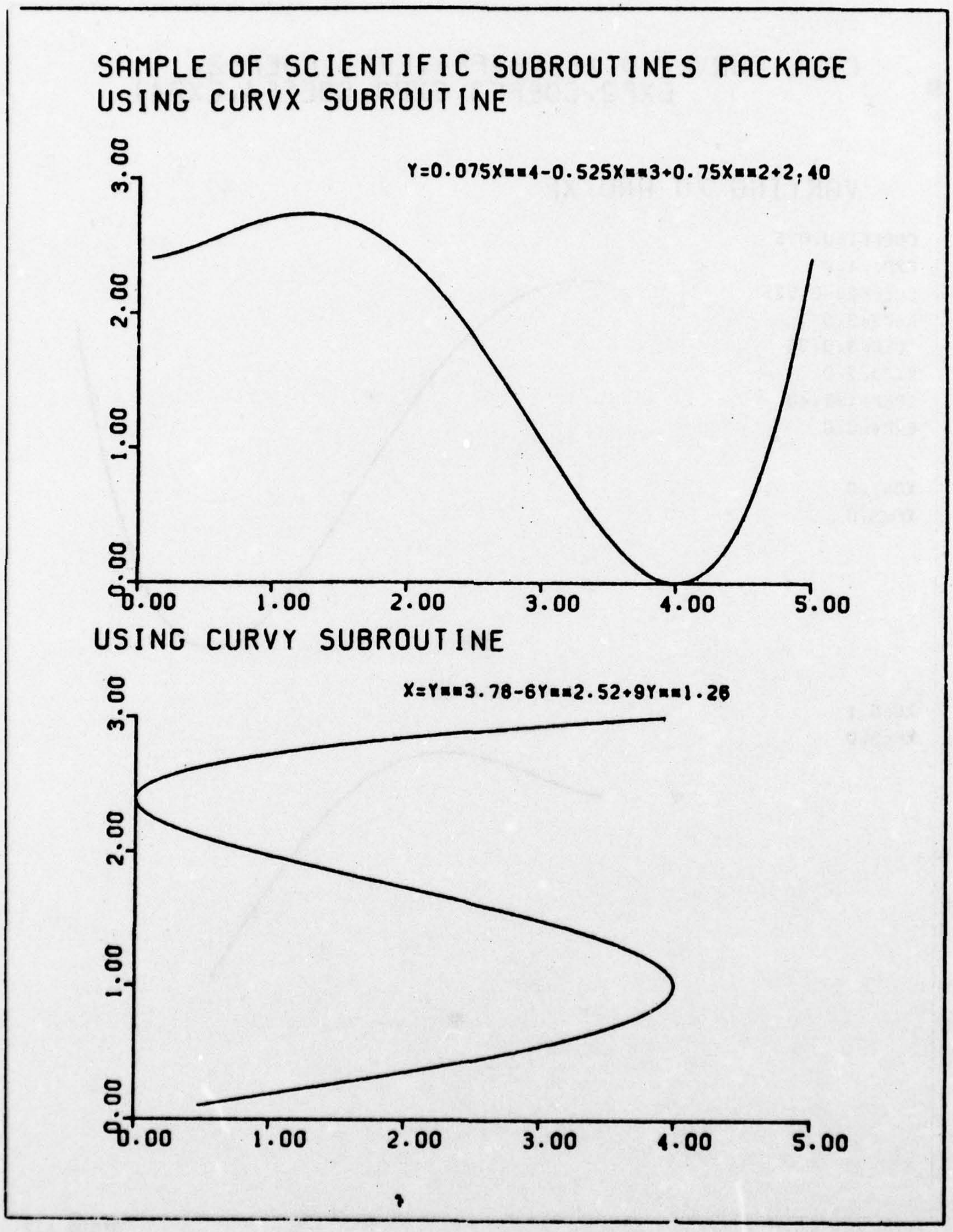
COEFF1=0.075
EXP1=4.0
COEFF2=-0.525
EXP2=3.0
COEFF3=0.75
EXP3=2.0
COEFF4=2.40
EXP4=0.0

XO=1.0
XF=5.0

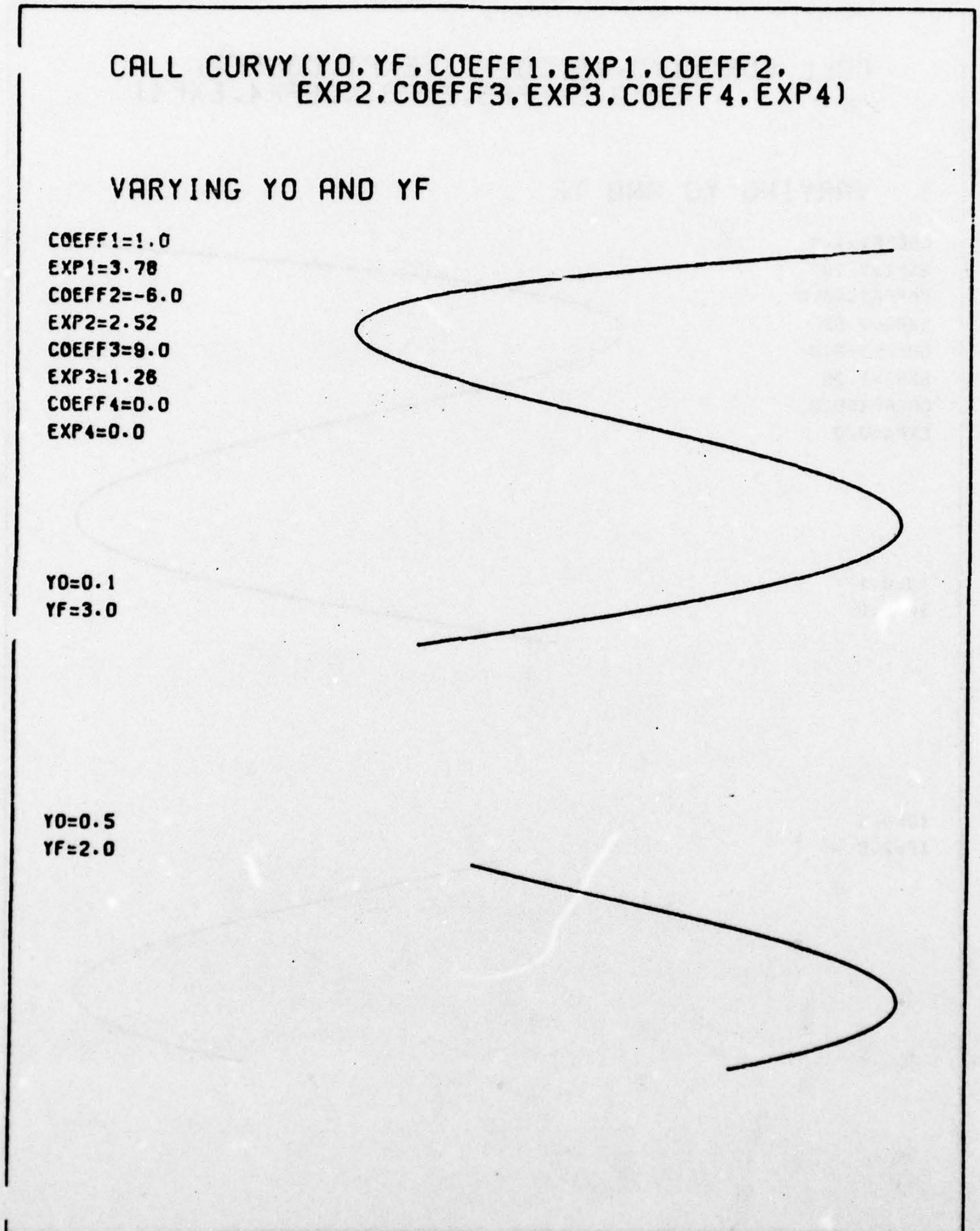
XO=0.1
XF=3.0



SLIDE A12


SAMPLE OF SCIENTIFIC SUBROUTINES PACKAGE
USING CURVX SUBROUTINE
Y=0.075X**4-0.525X**3+0.75X**2+2.40
0.00
1.00
2.00
3.00
0.00
1.00
2.00
3.00
4.00
5.00
USING CURVY SUBROUTINE
X=Y**3.78-6Y**2.52+9Y**1.26
0.00
1.00
2.00
3.00
0.00
1.00
2.00
3.00
4.00
5.00

SLIDE A13


CALL CURVY(YO,YF,COEFF1,EXP1,COEFF2,
EXP2,COEFF3,EXP3,COEFF4,EXP4)
VARYING YO AND YF
COEFF1=1.0
EXP1=3.78
COEFF2=-6.0
EXP2=2.52
COEFF3=9.0
EXP3=1.26
COEFF4=0.0
EXP4=0.0
YO=0.1
YF=3.0
YO=0.5
YF=2.0

SLIDE A14

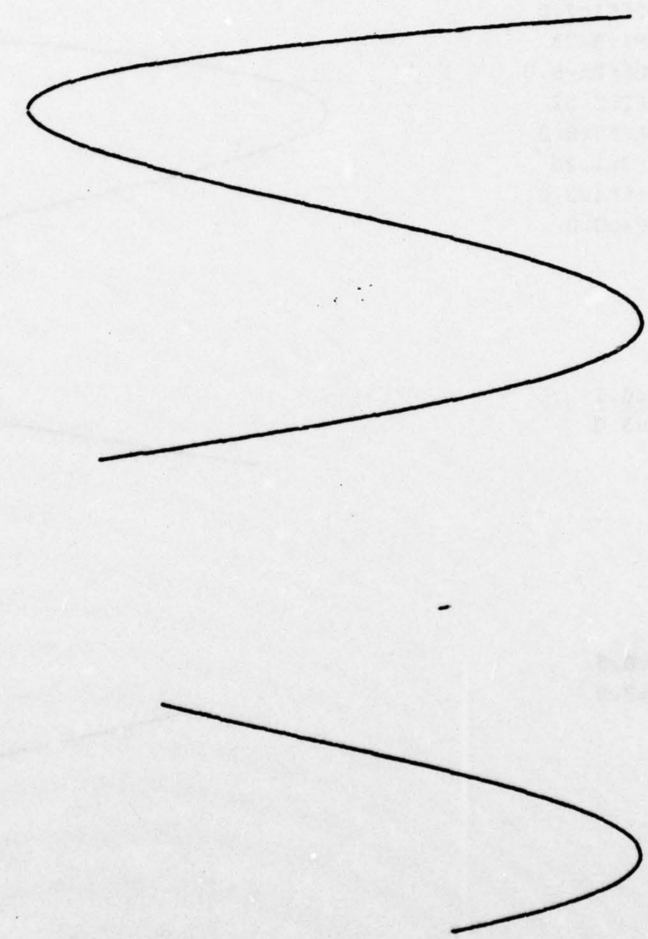
CALL CURVY(YO,YF,COEFF1,EXP1,COEFF2,
EXP2,COEFF3,EXP3,COEFF4,EXP4)

VARYING YO AND YF

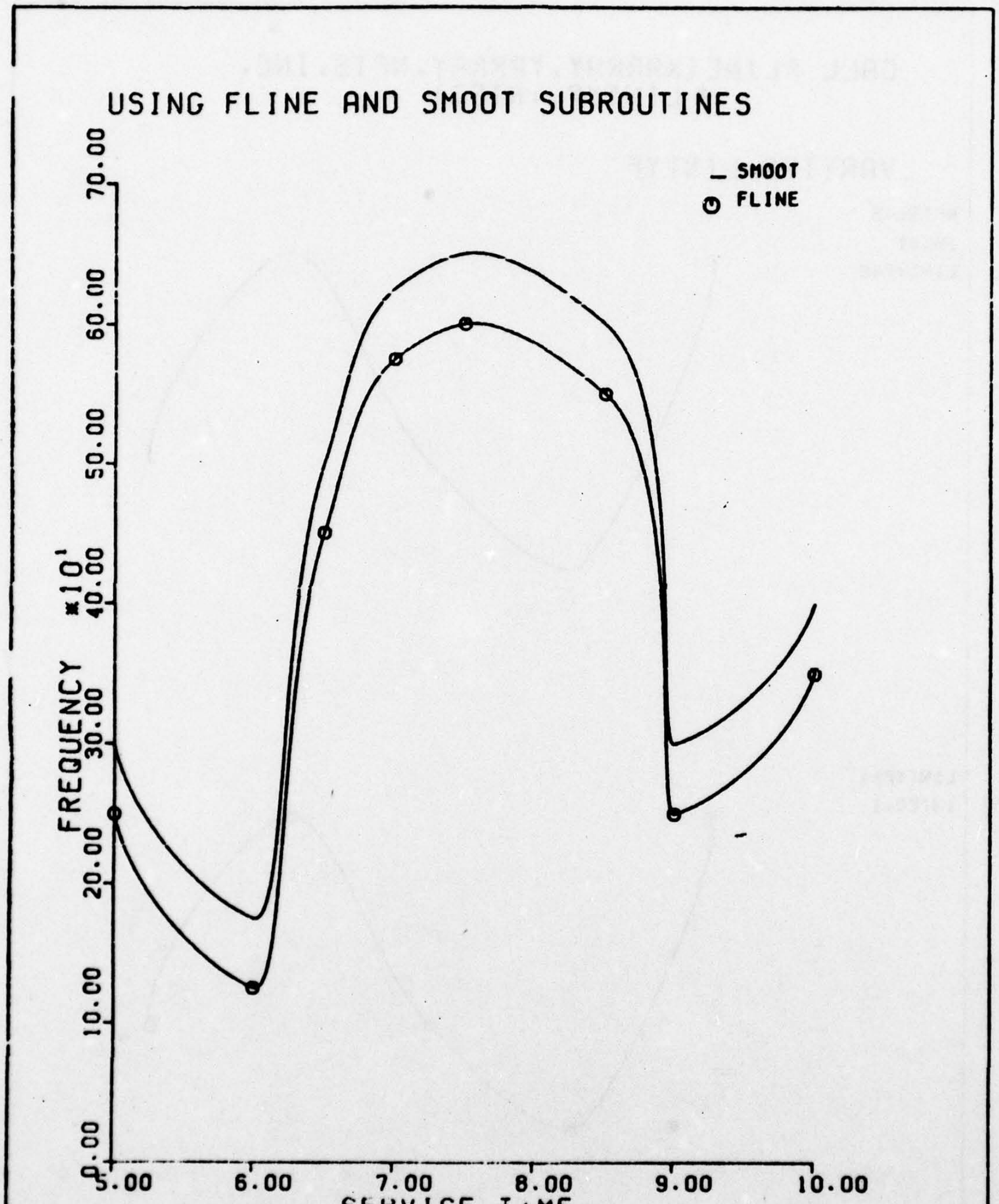
COEFF1=1.0
EXP1=3.78
COEFF2=-6.0
EXP2=2.52
COEFF3=9.0
EXP3=1.26
COEFF4=0.0
EXP4=0.0

YO=0.1
YF=3.0

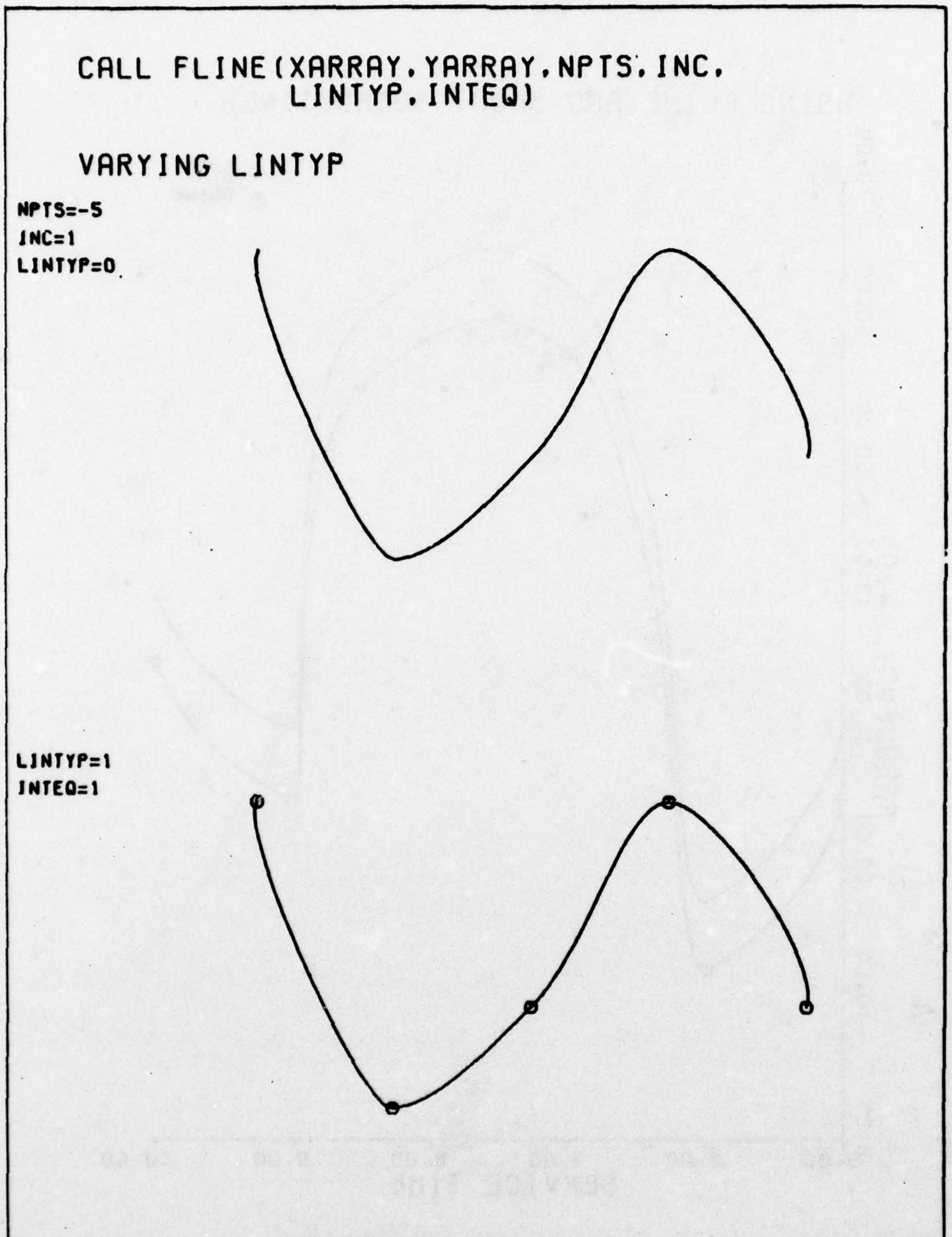
YO=0.5
YF=2.0



SLIDE A15


USING FLINE AND SMOOT SUBROUTINES
SMOOT
FLINE
FREQUENCY *10¹
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
5.00
6.00
7.00
8.00
9.00
10.00
SERVICE TIME

SLIDE A16


CALL FLINE(XARRAY,YARRAY,NPTS,INC,
LINTYP,INTEQ)
VARYING LINTYP
NPTS=-5
INC=1
LINTYP=0
LINTYP=1
INTEQ=1

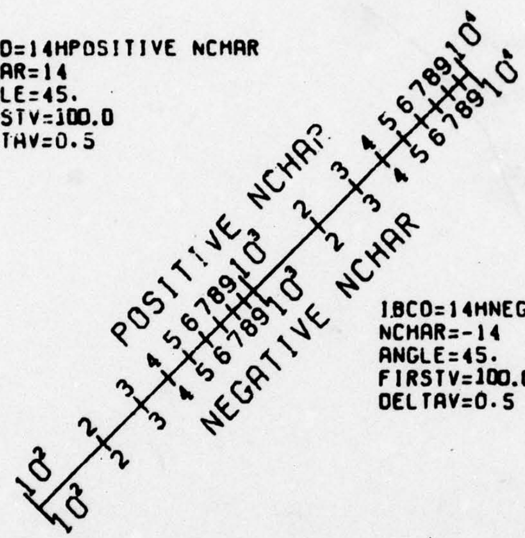
SLIDE A17

CALL LGAXS (XPAGE,YPAGE,IBCD,NCHAR,AXLEN,
ANGLE,FIRSTV,DELTAV)

VARYING NCHAR,ANGLE,FIRSTV,AND DELTAV

AXLEN=4.0

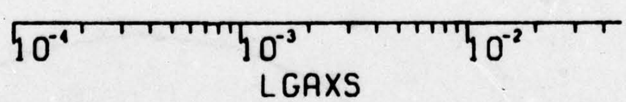
IBCD=14HPOSITIVE NCHAR
NCHAR=14
ANGLE=45.
FIRSTV=100.0
DELTAV=0.5



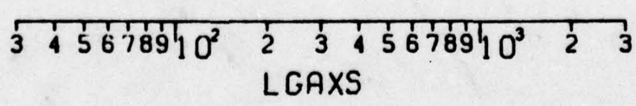
IBCD=14HNEGATIVE NCHAR
NCHAR=-14
ANGLE=45.
FIRSTV=100.0
DELTAV=0.5

IBCD=5HLGAXS
NCHAR=-6
ANGLE=0.

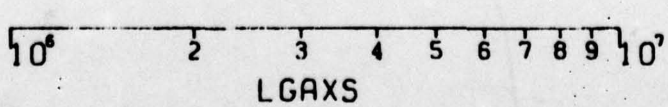
FIRSTV=0.0001
DELTAV=0.67



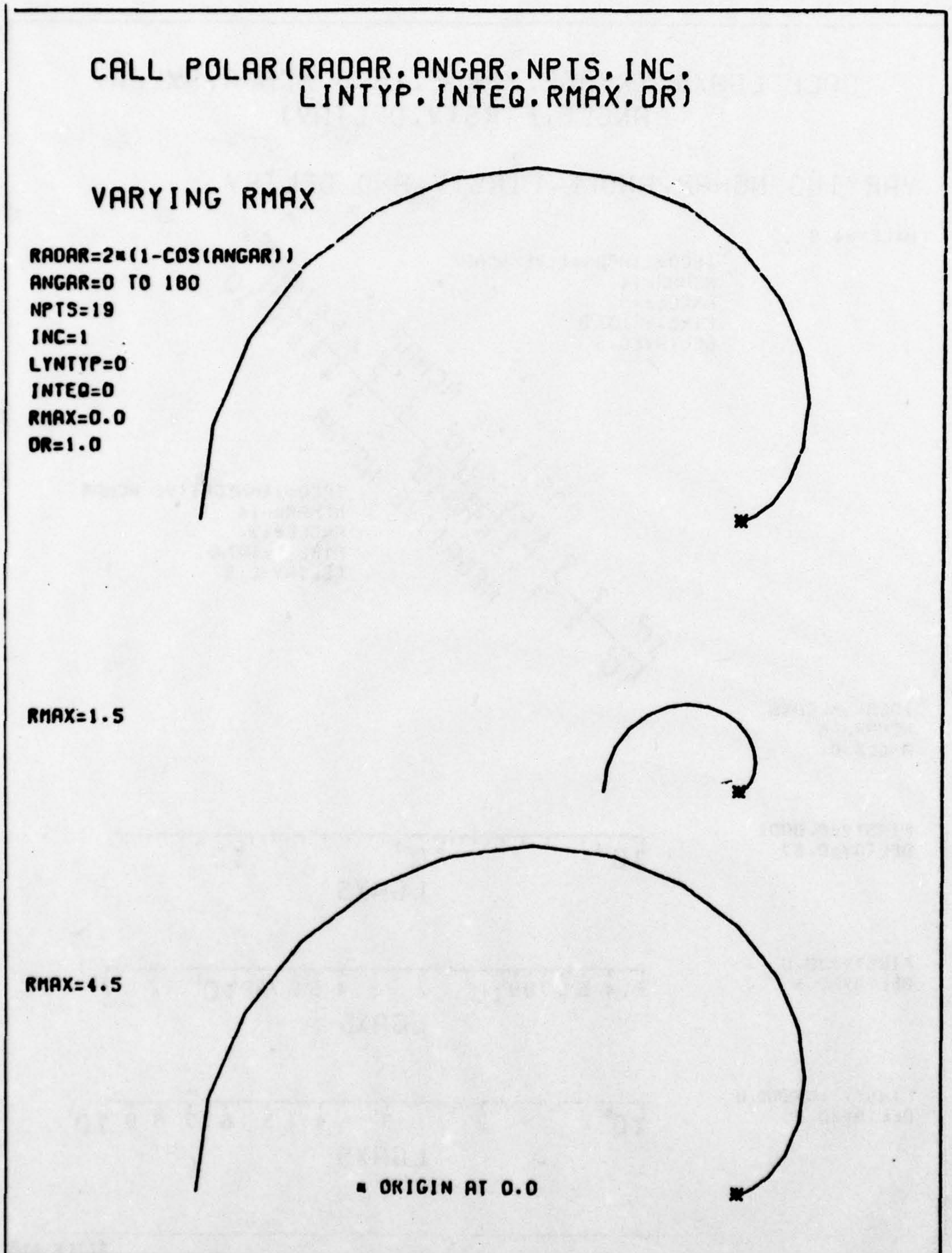
FIRSTV=30.0
DELTAV=0.5



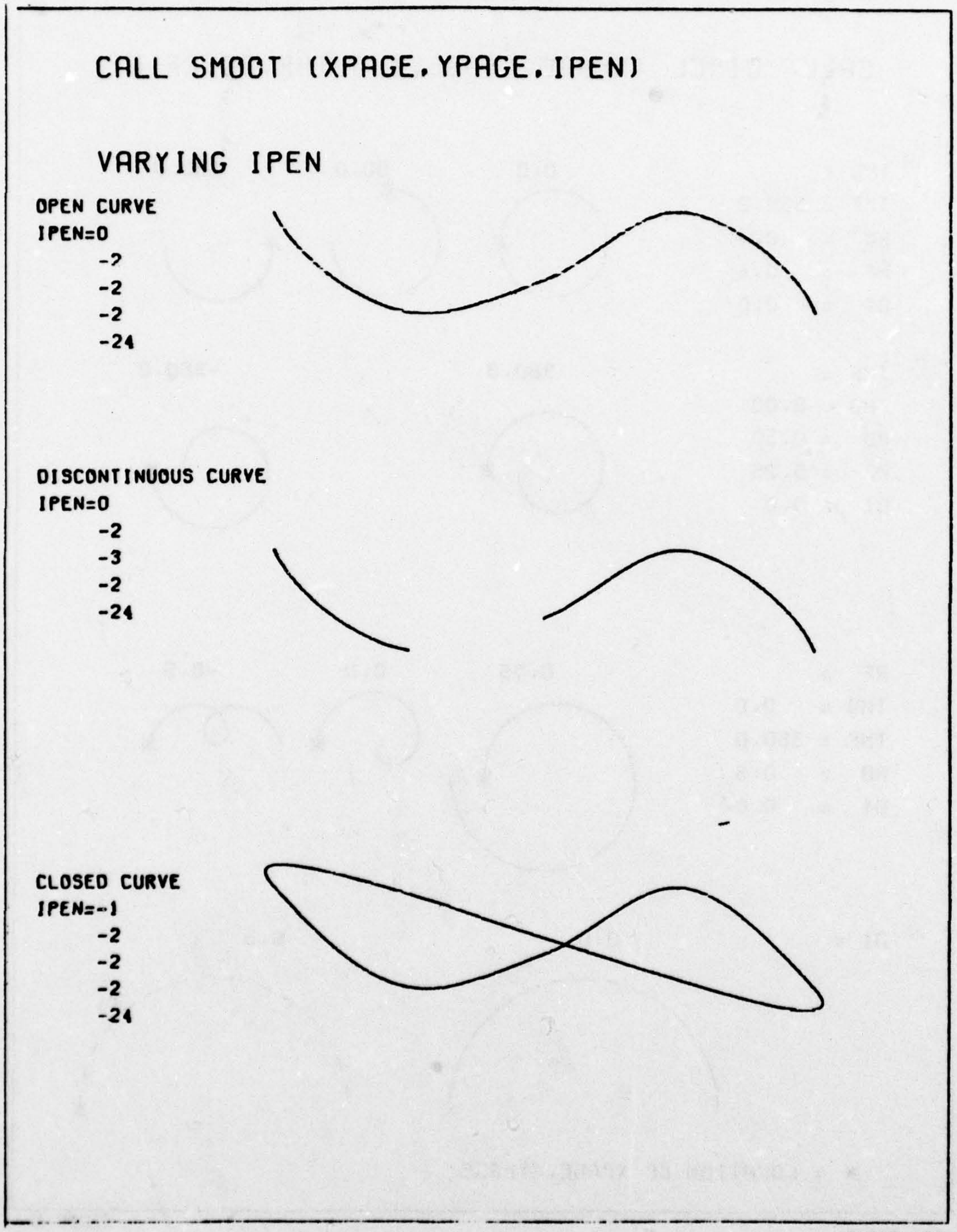
FIRSTV=1000000.0
DELTAV=0.25



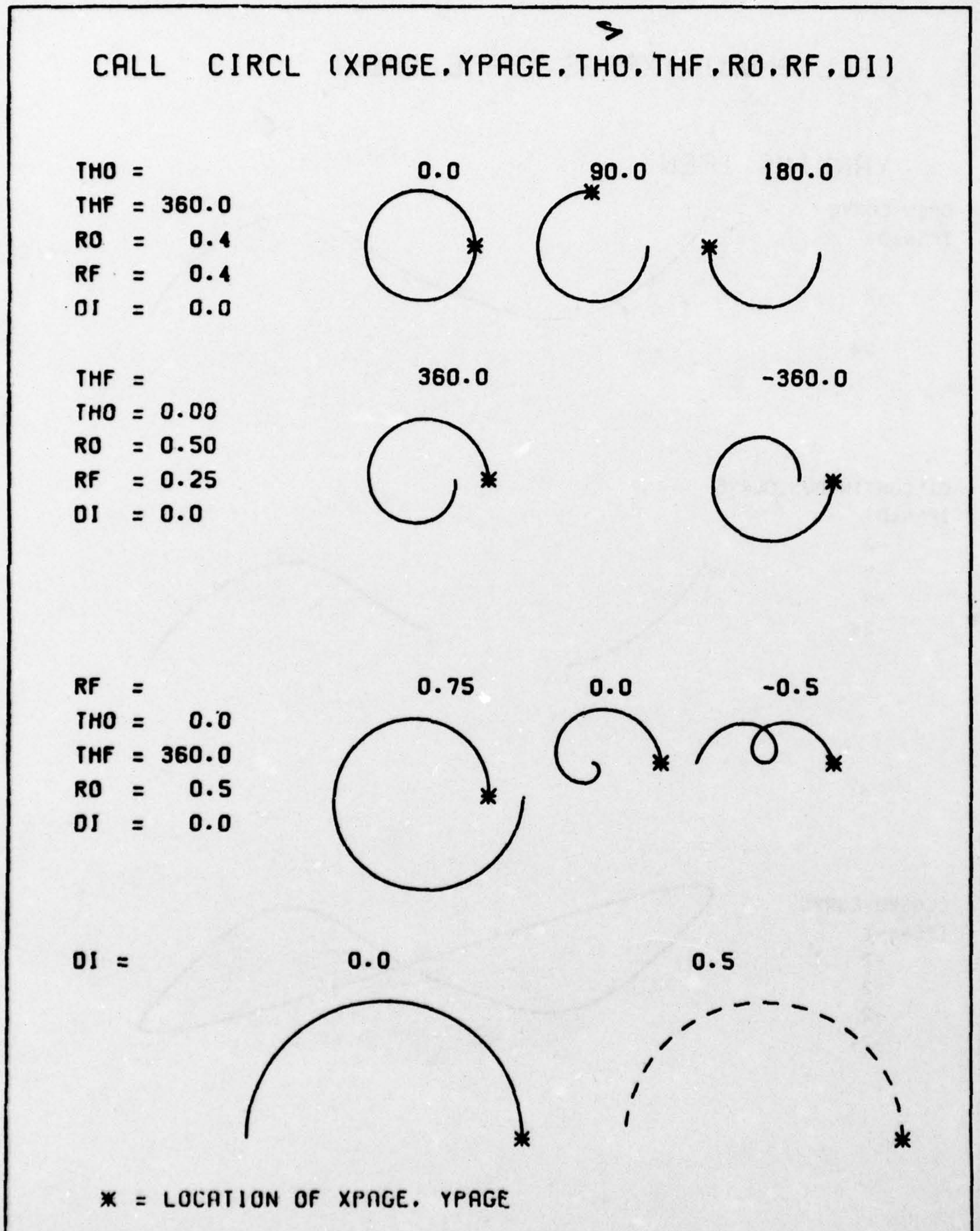
SLIDE A18


CALL POLAR(RADAR.ANGAR.NPTS.INC.
LINTYP.INTEQ.RMAX.DR)
VARYING RMAX
RADAR=2*(1-COS(ANGAR))
ANGAR=0 TO 180
NPTS=19
INC=1
LYNTYP=0
INTEQ=0
RMAX=0.0
DR=1.0
RMAX=1.5
RMAX=4.5
* ORIGIN AT 0.0

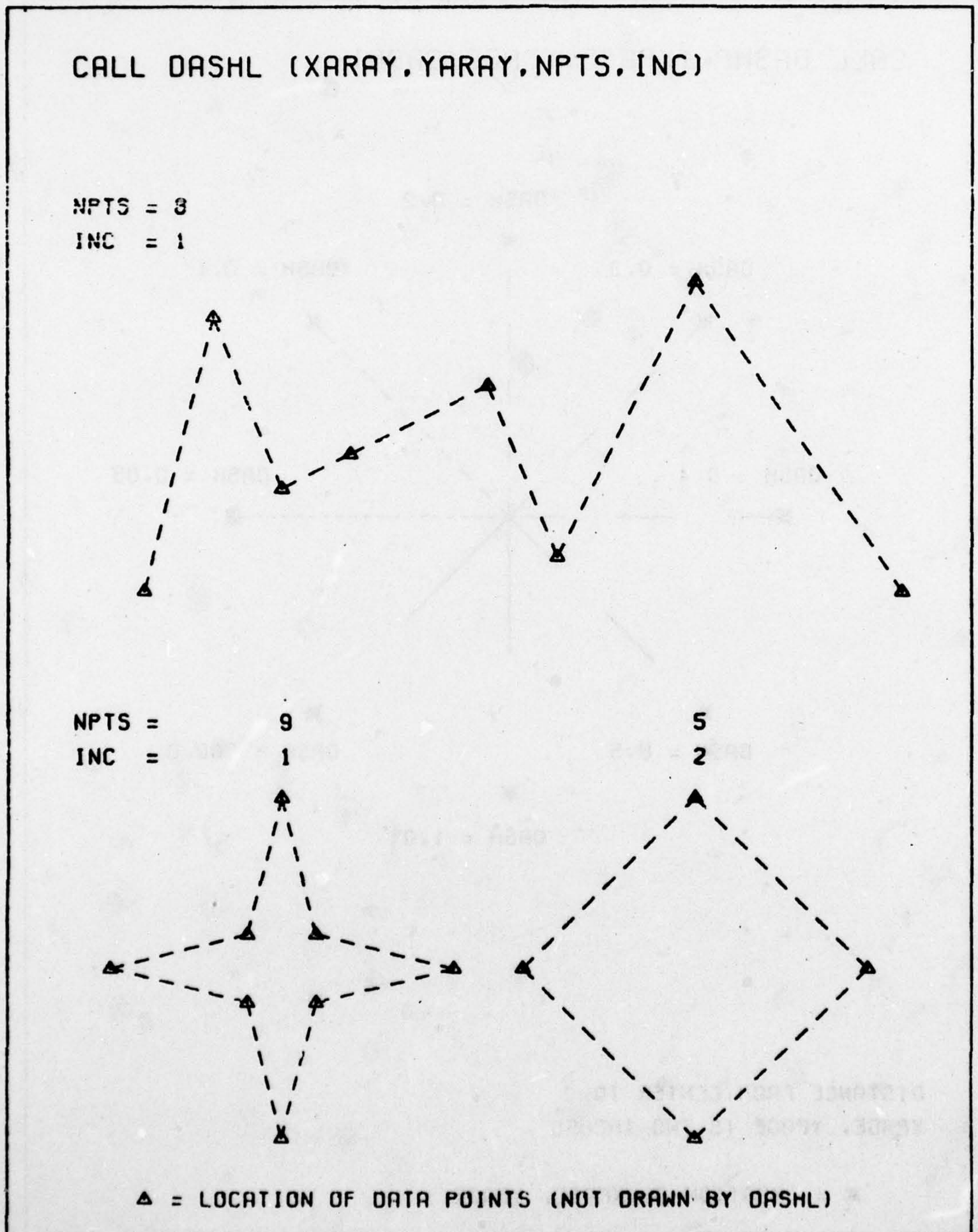
SLIDE A19


CALL SMOOT (XPAGE,YPAGE,IPEN)
VARYING IPEN
OPEN CURVE
IPEN=0
-2
-2
-2
-24
DISCONTINUOUS CURVE
IPEN=0
-2
-3
-2
-24
CLOSED CURVE
IPEN=-1
-2
-2
-2
-24

SLIDE A20

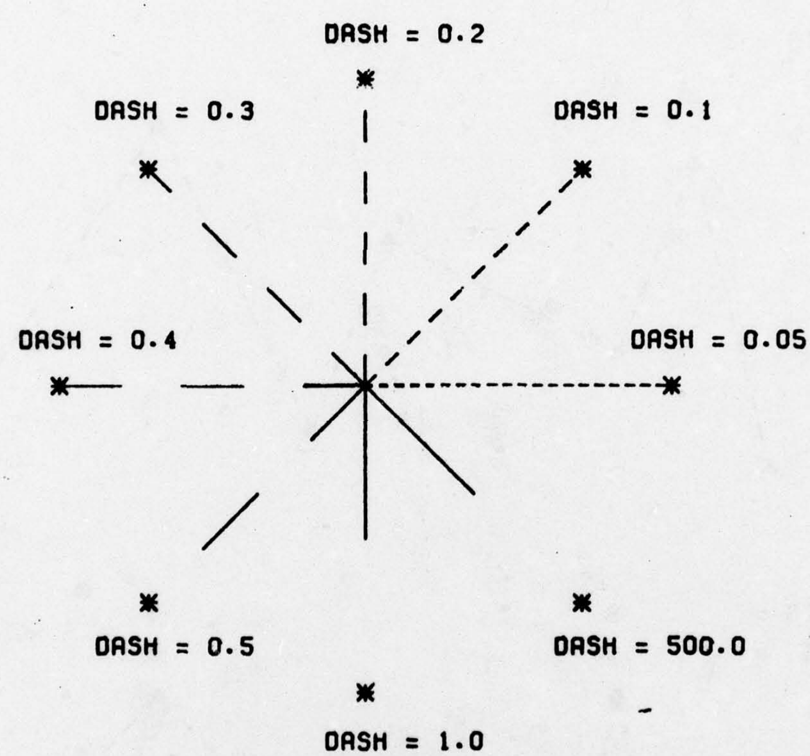

CALL CIRCL (XPAGE,YPAGE,THO,THF,RO,RF,DI)
THO =
THF = 360.0
RO = 0.4
RF = 0.4
DI = 0.0
0.0
90.0
180.0
THF =
THO = 0.00
RO = 0.50
RF = 0.25
DI = 0.0
360.0
-360.0
RF =
THO = 0.0
THF = 360.0
RO = 0.5
DI = 0.0
0.75
0.0
-0.5
DI =
0.0
0.5
* = LOCATION OF XPAGE, YPAGE

SLIDE A21


CALL DASHL (XARAY,YARAY,NPTS,INC)
NPTS = 8
INC = 1
NPTS = 9 5
INC = 1 2
= LOCATION OF DATA POINTS (NOT DRAWN BY DASHL)

SLIDE A22

CALL DASHP (XPAGE,YPAGE,DASH)



DISTANCE FROM CENTER TO
XPAGE, YPAGE IS TWO INCHES

* = LOCATION OF XPAGE, YPAGE

SLIDE A23

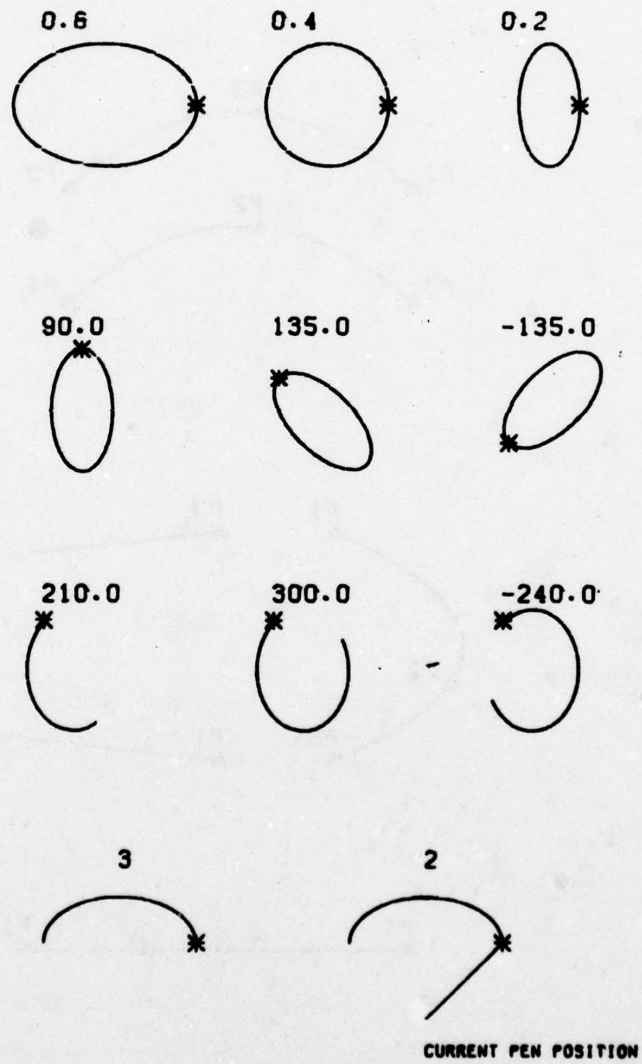
CALL ELIPS (XPAGE, YPAGE, RMAJ, RMIN, ANGLE
THO, THF, IPEN)

RMAJ =
RMIN = 0.4
ANGLE = 0.0
THO = 0.0
THF = 360.0
IPEN = 3

ANGLE =
RMAJ = 0.4
RMIN = 0.2
THO = 0.2
THF = 360.0
IPEN = 3

THF =
RMAJ = 0.4
RMIN = 0.3
ANGLE = 90.0
THO = 30.0
IPEN = 3

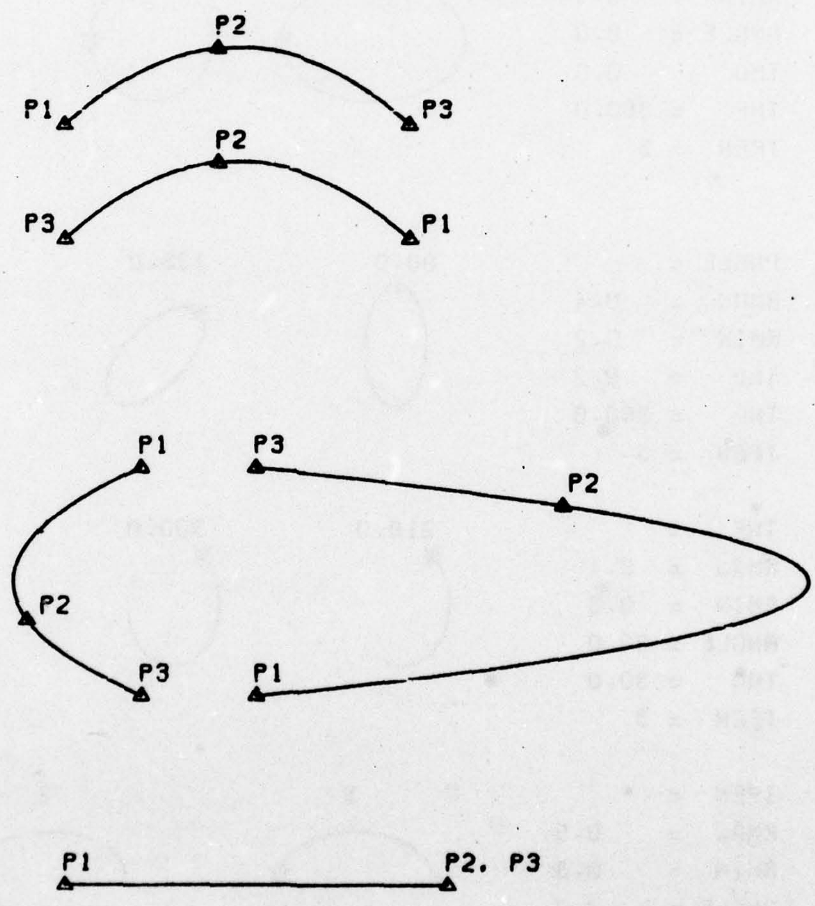
IPEN =
RMAJ = 0.5
RMIN = 0.3
ANGLE = 0.0
THO = 0.0
THF = 180.0



* = LOCATION OF XPAGL, YPAGE

SLIDE A24

CALL FIT (XPAGE1, YPAGE1, XPAGE2, YPAGE2, XPAGE3, YPAGE3)

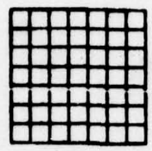


△ = LOCATION OF DATA POINTS (NOT DRAWN BY FIT)

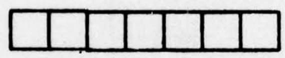
SLIDE A25

CALL GRID (XPAGE,YPAGE,DELTAX,DELTAY,NXSP,NYSP)

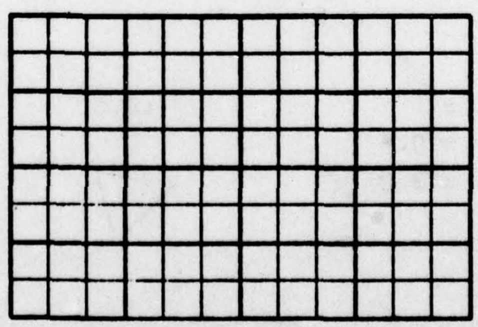
DELTAX = 0.125
DELTAY = 0.125
NXSP = 7
NYSP = 7



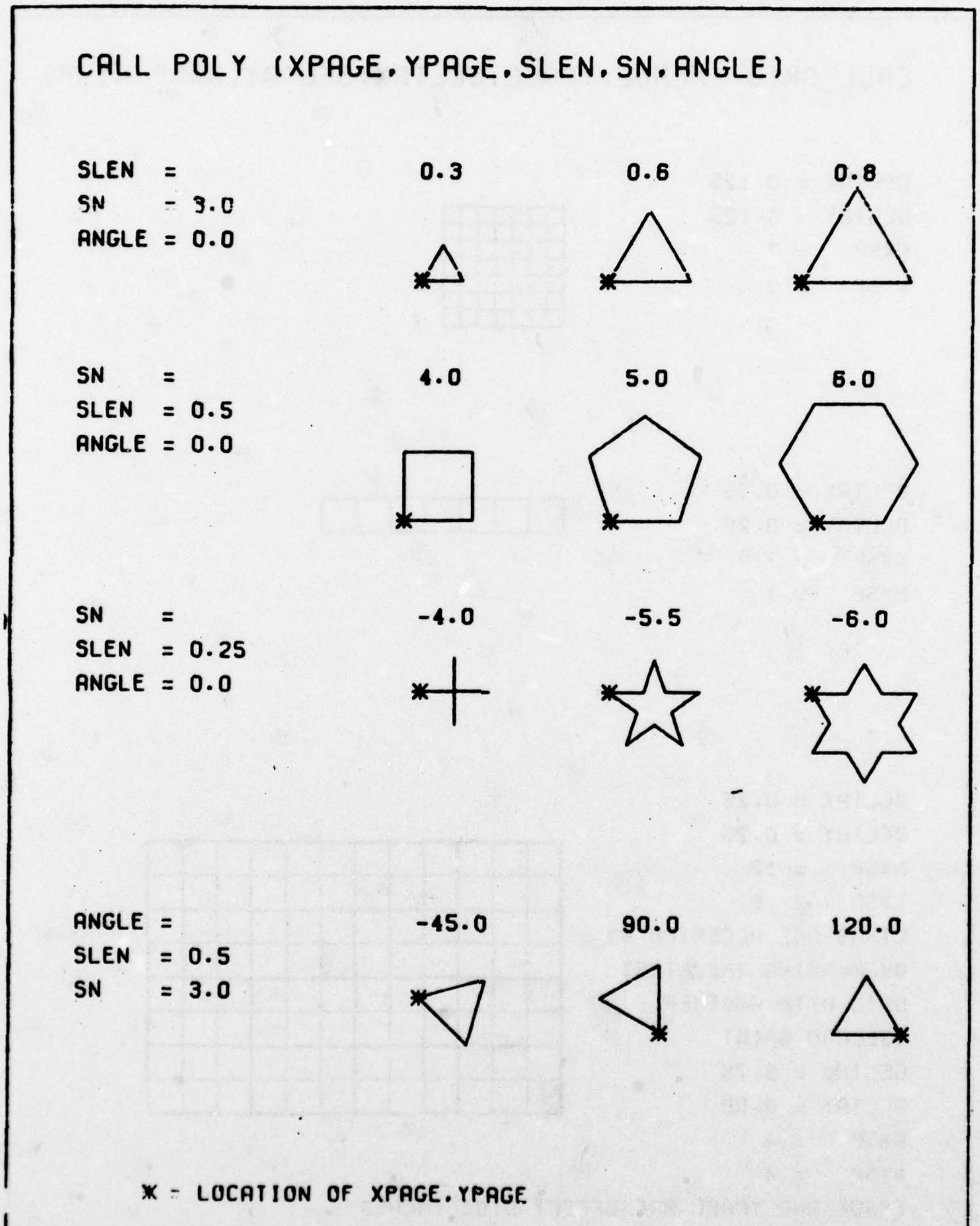
DELTAX = 0.25
DELTAY = 0.25
NXSP = 7
NYSP = 1



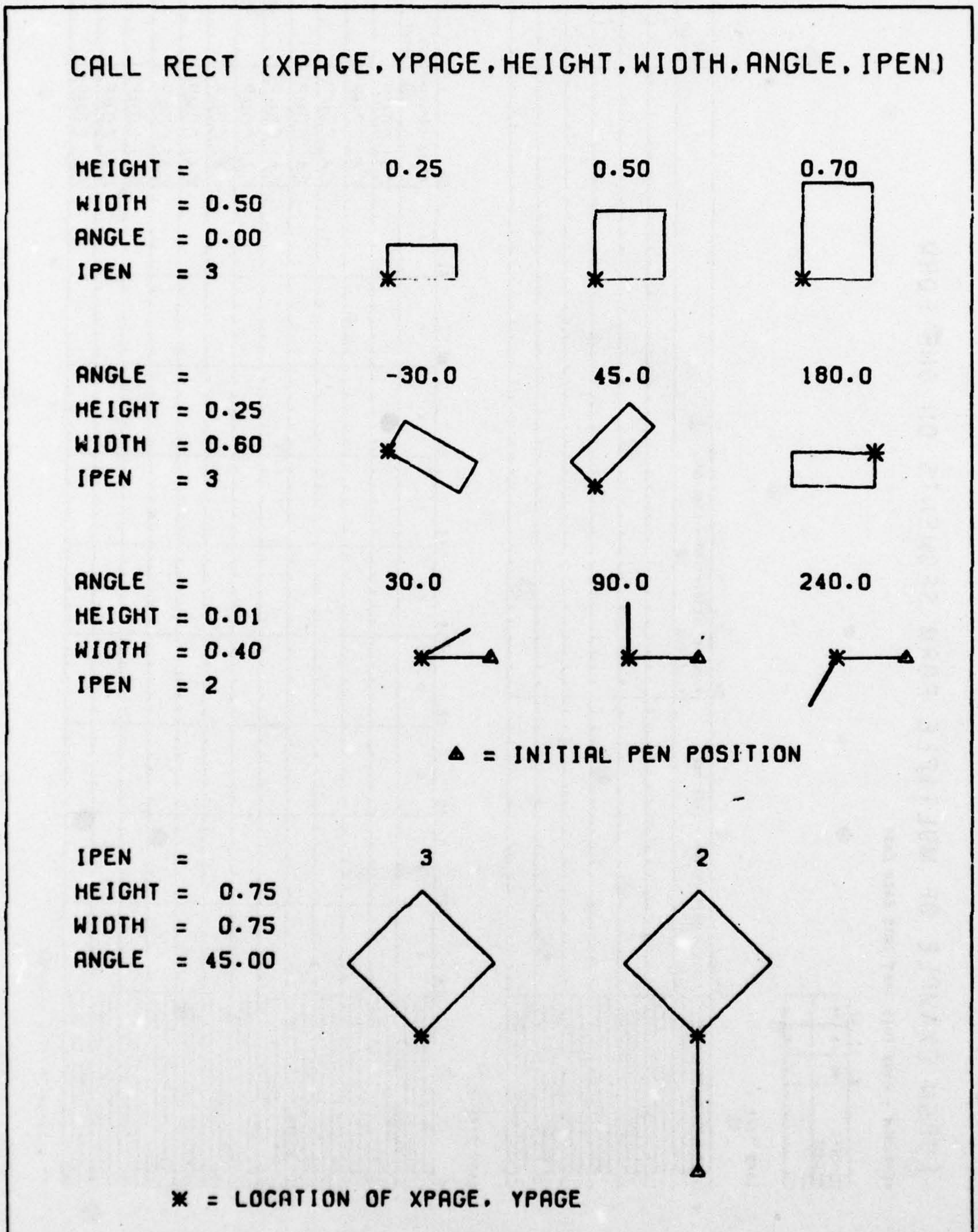
DELTAX = 0.25
DELTAY = 0.25
NXSP = 12
NYSP = 8
LINES ARE ACCENTED BY
OVERLAYING THE FIRST
GRID WITH ANOTHER.
(SECOND GRID)
DELTAX = 0.75
DELTAY = 0.50
NXSP = 4
NYSP = 4
XPAGE AND YPAGE ARE OFFSET 0.01 INCHES



SLIDE A26


CALL POLY (XPAGE,YPAGE,SLEN,SN,ANGLE)
SLEN =
SN = 3.0
ANGLE = 0.0
0.3
0.6
0.8
SN =
SLEN = 0.5
ANGLE = 0.0
4.0
5.0
6.0
SN =
SLEN = 0.25
ANGLE = 0.0
-4.0
-5.5
-6.0
ANGLE =
SLEN = 0.5
SN = 3.0
-45.0
90.0
120.0
* = LOCATION OF XPAGE,YPAGE

SLIDE A27


CALL RECT (XPAGE,YPAGE,HEIGHT,WIDTH,ANGLE,IPEN)
HEIGHT =
WIDTH = 0.50
ANGLE = 0.00
IPEN = 3
0.25
0.50
0.70
ANGLE =
HEIGHT = 0.25
WIDTH = 0.60
IPEN = 3
-30.0
45.0
180.0
ANGLE =
HEIGHT = 0.01
WIDTH = 0.40
IPEN = 2
30.0
90.0
240.0
▲ = INITIAL PEN POSITION
IPEN =
HEIGHT = 0.75
WIDTH = 0.75
ANGLE = 45.00
3
2
✱ = LOCATION OF XPAGE, YPAGE

SLIDE A28

FORGN EXAMPLE OF MULTIPLE FORM SEGMENTS ON ONE FORM

KEYPUNCH - GANG THIS INFO INTO EACH CARD

1	8	10	12
IDENT CODE	MO	DA	YR

CARD TYPE 1

1	14	34	76 80
C	FIELD A DESCRIPTION - LINE ONE LINE TWO	FIELD B DESCRIPTION - LINE ONE LINE TWO	JOB IDENT
1			
1			
1			
1			
1			
1			

CARD TYPE 2

1	14	20	26	32	38	44	50	56	62	68	76 80
C	A	B	C	D	E	F	G	H	I	FIELD CONSTANT	JOB IDENT
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	
2										CALCOMP	

-- M 13-68 REVISED 4-09-68

SLIDE A29

DISSPLA/TEL-A-GRAF

DISPLA

A Presentation Given By

JOHN N. LAMBRECHT

NASHVILLE ENGINEER DISTRICT

At The

COMPUTER GRAPHICS COLLOQUIUM

WATERWAYS EXPERIMENT STATION

Vicksburg, Mississippi

1 - 3 AUGUST 1978

A B C D E F

A B C D E F

A B C D E F

A B C D E F

A B C D E F

A B C D E F

A B C D E F

A B C D E F

FIGURE 1

a b c d e f

a b c d e f

a b c d e f

a b c d e f

a b c d e f

a b c d e f

a b c d e f

a b c d e f

FIGURE 2

FIGURE 3

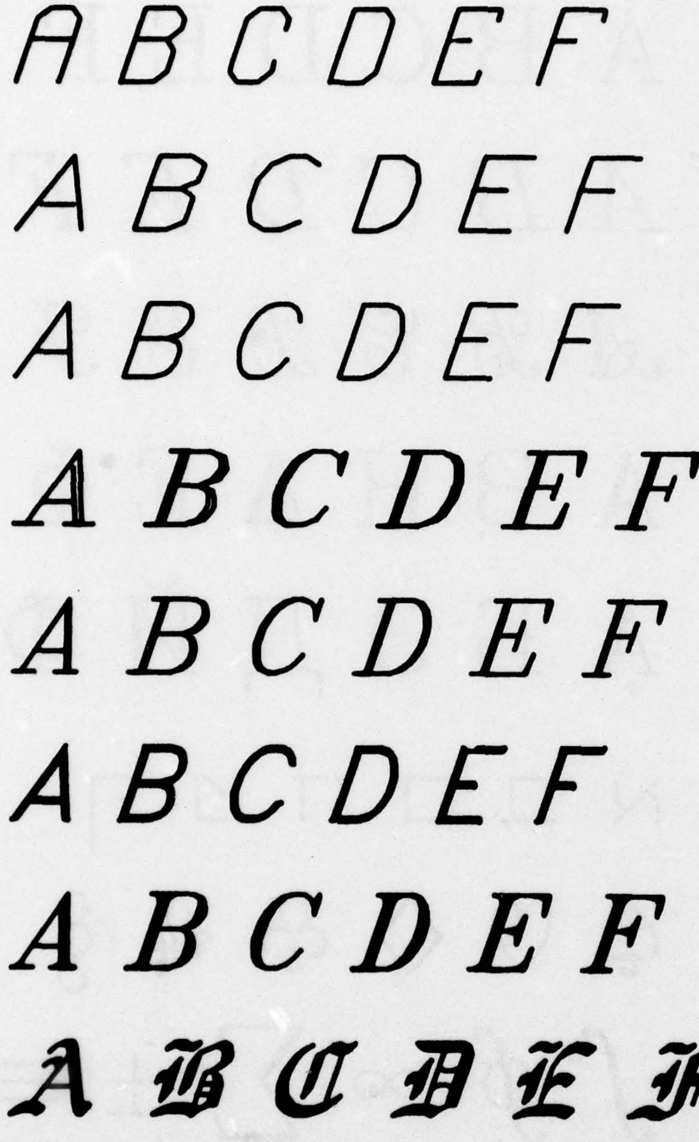


FIGURE 4

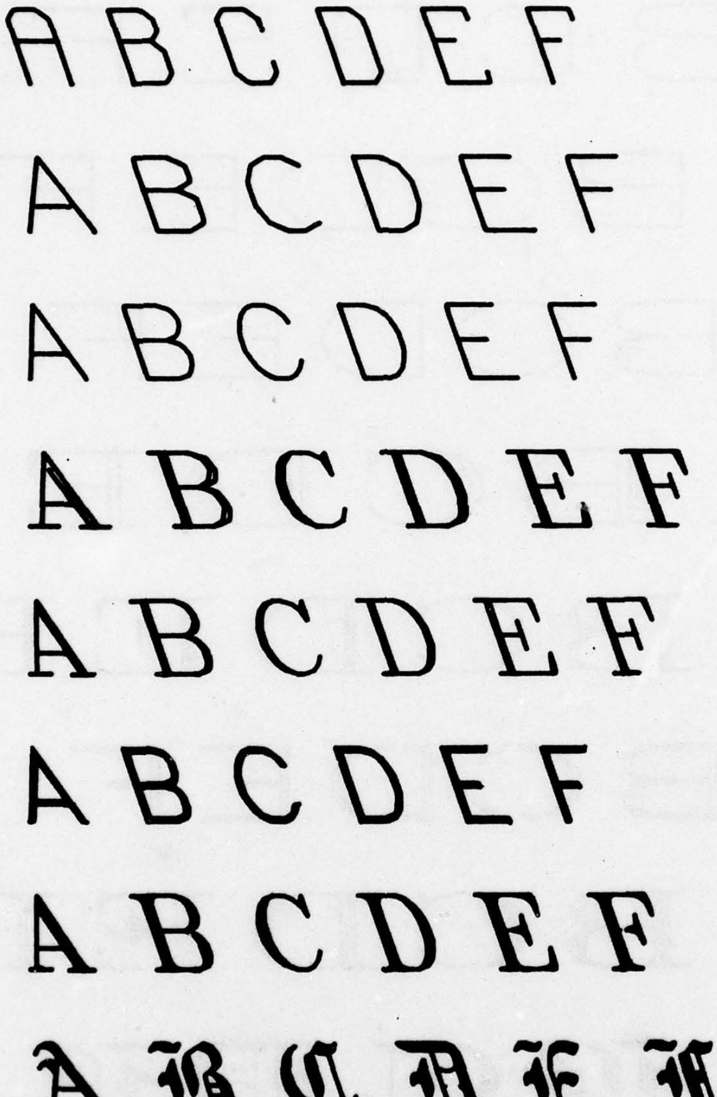


FIGURE 5

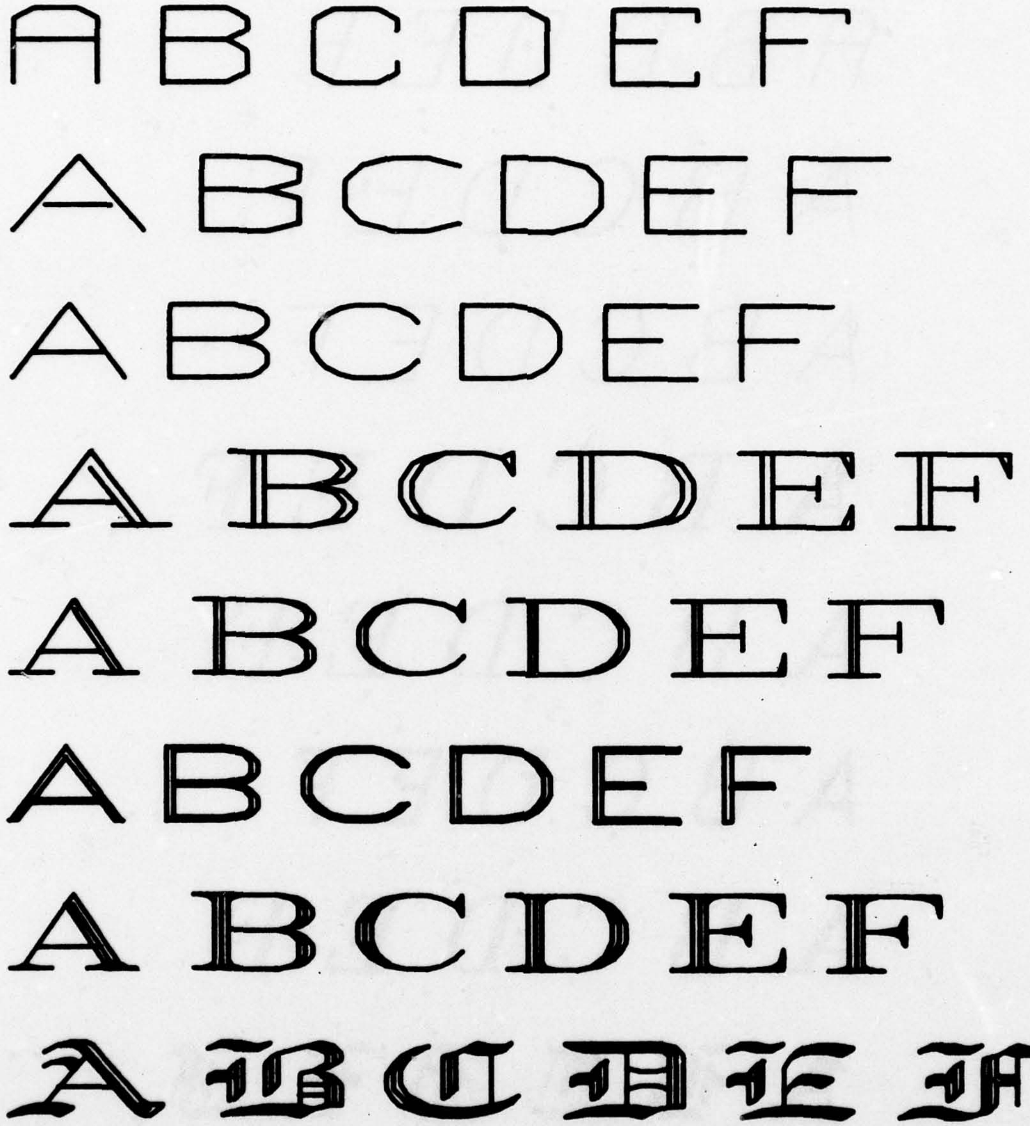


FIGURE 6

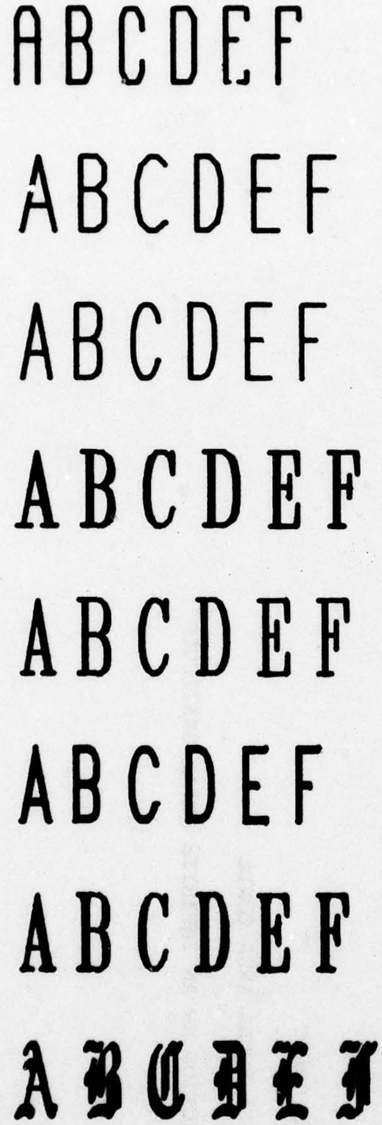


FIGURE 7

CYLINDRICAL EQUIDISTANT

MERCATOR

EXACT CYLINDRICAL EQUIDISTANT

CORRECTED MECATOR

MOLLEWEIDE

A IT OFF (HAMMERS PROCECTION)

SANSON (FLAMSTEAD) SINUSOIDAL

SIMPLE ELLIPTICAL

BI-PARALLEL CONFORMAL CONIC

BI-PARALLEL (ALBERT'S) EQUAL AREA CONIC

TRUE POLYCONIC PROJECTION ON AN INFINITE SMIAL GRATICULE

GNOMINIC

ORTHOGRAPHIC

STEREO GRAPHIC

AZIMUTHAL EQUIDISTANT

AZIMUTHAL (LAMBERT) EQUAL AREA

FIGURE 8

A Cylindrical Equi-Distant Map

spanning almost two cycles

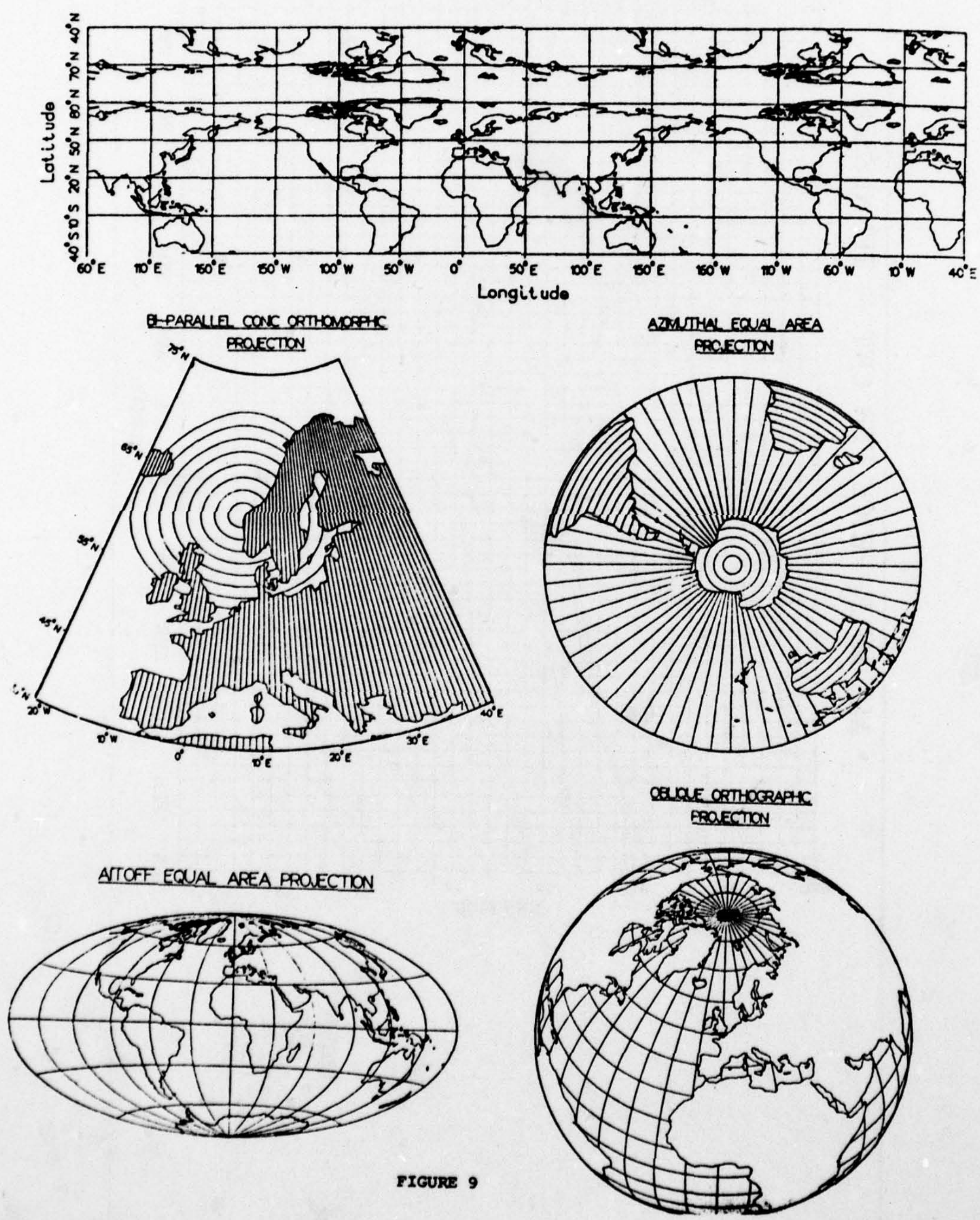
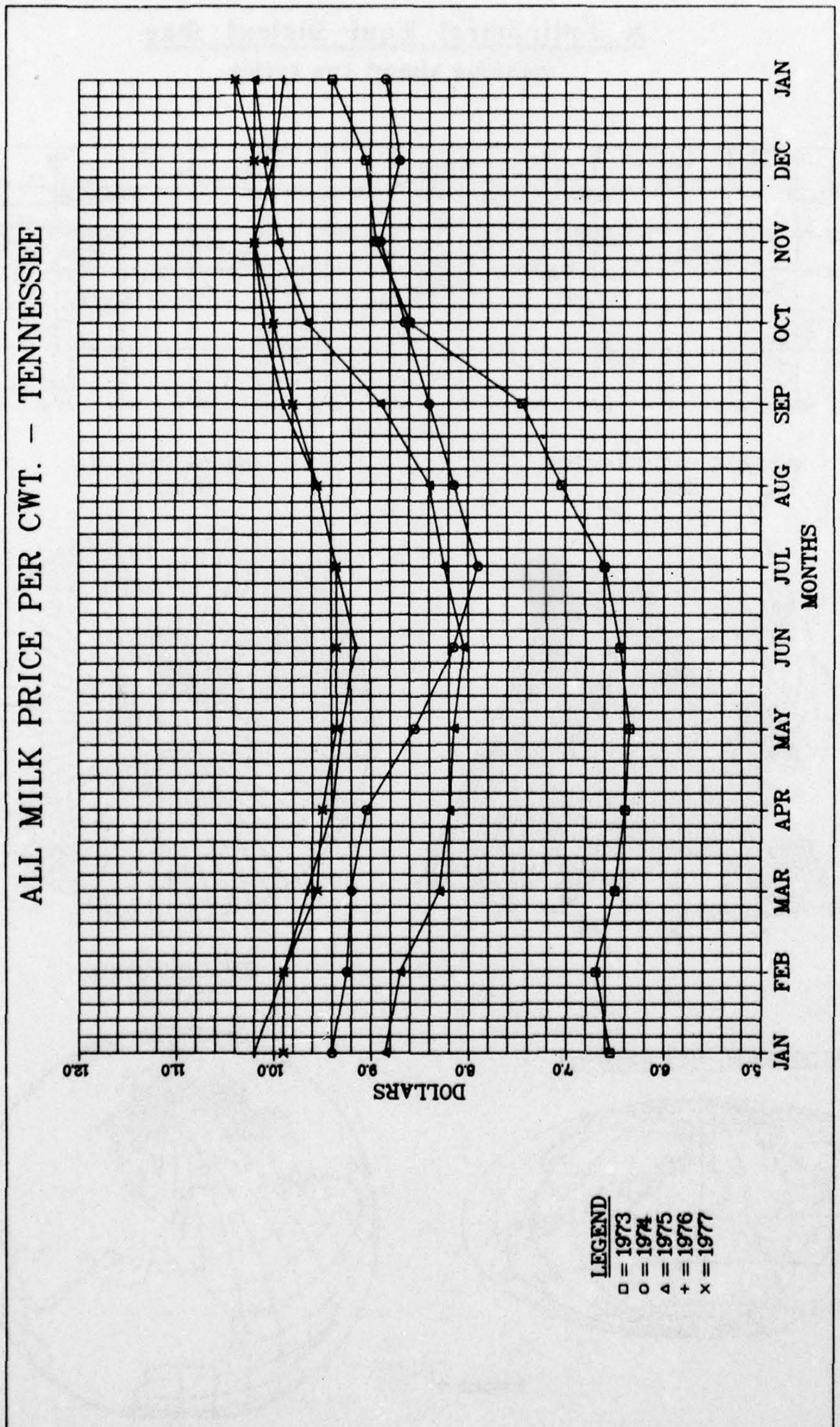
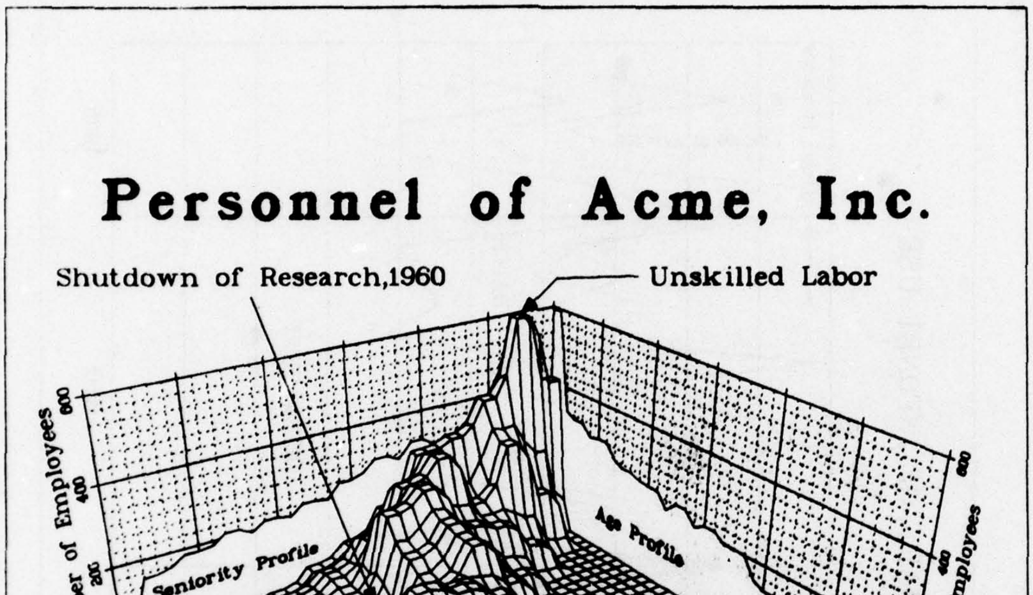
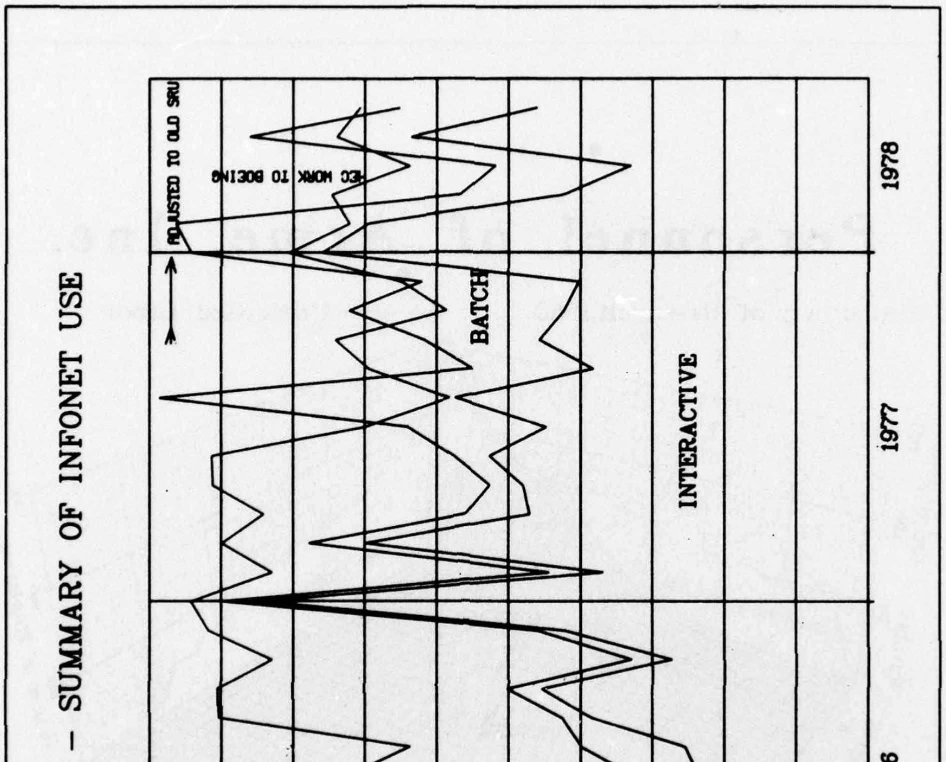


FIGURE 9



ALL MILK PRICE PER CWT. - TENNESSEE
DOLLARS
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
MONTHS
LEGEND
□ = 1973
○ = 1974
Δ = 1975
+ = 1976
× = 1977


Personnel of Acme, Inc.
Shutdown of Research,1960
Unskilled Labor
Number of Employees
Seniority Profile
Age Profile
Number of Employees
Number of Years with Company
Age in Years


NASHVILLE DISTRICT - SUMMARY OF INFONET USE
ADJUSTED TO OLD SRU
REC WORK TO BOEING
BATCH
INTERACTIVE
1975
1976
1977
1978
INFONET SRU'S
PERCENT INTERACTIVE

```
         1111111111222222222233333333334444444444555555555566666666667777777777B
1234567890123456789012345678901234567890123456789012345678901234567890123456789012‹4567890

UYH213                    603091    LIBS    AT  07/13/78 12 43 43 JOB ‹7416
C234567--0----5----0----5----0----5----0----5----0----5----0----5----012
C       60383091 PLOT INFONET SRU USAGE  1978 JULY 2 LAMBRECHT
       DIMENSION YLABEL(3),BAT(100),AINTER(100),TOT(100),X(100)
       DIMENSION LEG(4),INTER(2)
      DIMENSION ITITL(8),YLAB1(4),LBOE(3)
       DATA LBOE/_HEC TO BOEING_/
       DATA ITITL/_NASHVILLE DISTRICT - SUMMARY OF INFONET USE_/
       DATA INTER/_INTER-ACTIVE_/,IBAT/_BATCH_/
       DATA LEG/_ADJUSTED TO OLD SRU      _/
       DATA YLAB1/_PERCENT INTER-ACTIVE_/
       DATA FACT/.8/
       DATA YLABEL/_INFONET SRU__S_/
       XINC = .50
       READ (5,8001,PROMPT=_DEVICE   _) LDEV
 8001  FORMAT (A6)
       CALL OBEYV(_ SWITCH IN$ 603090,DA ,_)
       DO 10 I=1,100
       READ 8002,AINTER(I),BAT(I)
 8002  FORMAT (2F10.0)
       IF (AINTER(I) .LT. 0) GO TO 20
       IF (I .GT. 33) AINTER(I) = AINTER(I) / .68
       IF (I .GT. 33) BAT(I) = BAT(I) / .68
       TOT(I) = AINTER(I)   BAT(I)
       BAT(I) = 0.
       IF (TOT(I) .NE. 0.)
     1  BAT(I) = AINTER(I) / TOT(I) * 100.
       IF (I .NE. 1) X(I) = X(I-1)   XINC
   10  CONTINUE
   20  CONTINUE
       CALL OBEYV(_ SWITCH ,CLOSE ,_)
       N = I - 1
       AN = N
       XLEN = AN * XINC
       AINTER(N 1) = 0.
       AINTER(N 2) = 10000.
       TOT(N 1) = 0.
       BAT(N 2) = 10.
       BAT(N 1) = 0.
       TOT(N 2) = 10000.
       X(N 1) = 0.
       X(N 2) = 1.
       XL1 = XLEN   1.
       XL2 = XLEN   2.
       IXL = XL2 * FACT
       YLEN = 13.
       YUP = .5
       YL = YLEN   YUP   2.
       IYL = YL * FACT
       IF (LDEV .EQ. _CAL_) GO TO 50
       PRINT 9001,IXL,IYL

         1111111111222222222233333333334444444444555555555566666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890123‹4567890
```

```
         1111111111222222222233333333334444444444555555555566666666667777777777
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

 9001 FORMAT [_ USE_,I3,_ AND_,I3,_ FOR X AND Y SIZES,_]
      GO TO 70
   50 CONTINUE
      YUP = 2,
      CALL OBEYV[_ EQUATE 7 603091,PL ,_]
   70 CONTINUE
      CALL PLOTS[0,,0,,LDEV]
      CALL FACTOR[FACT]
      CALL PLOT[0,,-37,,-3]
      CALL PLOT[,25,YUP,-3]
      CALL PLOT[XL1,0,,2]
      CALL PLOT[XL1,YL,2]
      CALL PLOT[0,,YL,2]
      CALL PLOT[0,,0,,2]
      CALL PLOT[1,,1,,-3]
      CALL NEWPEN[2]
      CALL AXIS[-,5,0,,YLAB1,20,10,,90,,0,,10,]
      CALL NEWPEN[1]
      CALL AXIS[0,,0,,YLABEL,13,13,,90,,0,,10000,]
      X2 = [XLEN - 12,9] / 2,
      CALL SYMBOL[X2,13,60,,3,ITITL,0,0,43]
      YY = 0,
      DO 80 I = 1,13
      YY = YY   1,
      CALL PLOT[0,,YY,3]
      CALL PLOT[XLEN,YY,2]
   80 CONTINUE
      CALL PLOT[0,,0,,3]
      CALL PLOT[XLEN,0,,2]
      XXX = 11, * XINC
      NN = N - 12
      DO 90 I = 1,NN,12
      CALL PLOT[XXX,13,,3]
      CALL PLOT[XXX,-,25,2]
      XXX = XXX   12, * XINC
   90 CONTINUE
      CALL LINE[X,AINTER,N,1,0,0]
      CALL NEWPEN[2]
      CALL LINE[X,BAT,N,1,0,0]
      CALL NEWPEN[1]
      CALL LINE[X,TOT,N,1,0,0]
      XXX = [12, * XINC - 1,2] / 2,
      A = 1975,
      DO 150 I=1,N,12
      CALL NUMBER[XXX,-,4,,3,A,0,,-1]
      XXX = XXX   12, * XINC
      IF [XXX   1,2 ,GE, XLEN] XXX = XLEN - 1,4
      A = A   1,
  150 CONTINUE
      CALL PLOT[X[34],12,2,3]

         1111111111222222222233333333334444444444555555555566666666667777777777
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
```

```
         111111111122222222223333333333444444444455555555556666666666777777777778
123456789012345678901234567890123456789012345678901234567890123456789012345678 90

       CALL PLOT(X(34),12,5,2)
       CALL PLOT(X(34),12,35,3)
       CALL PLOT(X(35) ,5,12,35,2)
       CALL PLOT(X(35) ,3,12,45,2)
       CALL PLOT(X(35) ,5,12,35,3)
       CALL PLOT(X(35) ,3,12,25,2)
       CALL SYMBOL(X(35) ,6,12,3,,1,LEG,0,0,19)
       CALL SYMBOL(X(26),3,4,,2,INTER,0,0,12)
       CALL SYMBOL(X(33)-,22,6,16,,2,IBAT,0,0,5)
       CALL SYMBOL(X(39) XINC/2,,8,1,,12,LHOF,90,,13)
       CALL PLOT(0,,0,,999)
       IF (LDEV ,EQ, _TEK_) CALL HDCOPY
       IF (LDEV ,EQ, _TEK_) STOP
       ENDFILE 7
       CALL OBEYV(_ EQUATE,DROP ,_)
       CALL OBEYV(_ PLOT 603091,PL ,_)
       STOP
       END
```

```
  OPTIONS
   SRC
   CARD
   TEMP
   CROSS
   ISD
      C       0         0         0         0         0         0         0         0
      C
      C       PROGRAM TO COMPARE DISSPLA GRAPHICS WITH CALCOMP GRAPHICS
      C
      C       SAM E. BRADLEY, JR.      U. S. ARMY CORPS OF ENGINEERS
      C       NASHVILLE DISTRICT        ADP CENTER       JULY 1978
      C
              DIMENSION X(100),BATCH(100),AINTER(100),TOTAL(100),PERCNT(100)
              DIMENSION LTITLE(20),LYNAM1(20),LYNAM2(20)
              DIMENSION LBATCH(2),LINTER(3),LABELX(2),LHEC(5),LADJST(7)
              DATA IDOLLR/'$'/
              DATA LADJST/'ADJUSTED TO OLD SRUS'/
              DATA LBATCH/'BATCHS'/
              DATA LHEC/'HEC WORK TO BOEINGS'/
              DATA LINTER/'INTERACTIVES'/
              DATA LTITLE/'NASHVILLE DISTRICT - SUMMARY OF INFONET USES'/
              DATA LYNAM1/'INFONET SRU''SS'/
              DATA LYNAM2/'PERCENT INTERACTIVES'/
              CALL OBEYV('ISWITCH INS:603090,DA  .  ')
              YMIN=0.0
              YMAX=-9999999.0
      C
      C       READ IN AND STORE DATA
      C
          100 DO 130 I=1,101
              READ(5,1000,END=140)AINTER(I),BATCH(I)
         1000 FORMAT(2F10.0)
              IF(I .LT. 34) GO TO 120
          110 AINTER(I)=AINTER(I)/0.68
              BATCH(I)=BATCH(I)/0.68
          120 X(I)=I-1
              TOTAL(I)=AINTER(I)+BATCH(I)
              IF(YMAX .LT. TOTAL(I)) YMAX=TOTAL(I)
FR5307 I 34.  TEST BETWEEN NON INTEG
              IF(TOTAL(I) .EQ. 0.0) GO TO 130
              PERCNT(I)=(AINTER(I)/TOTAL(I))*100.0
          130 CONTINUE
          140 NPTS=I-1
              XMAX=NPTS
          150 CALL OBEYV('ISWITCH ,CLOSE  .  ')
      C
      C       INITIALIZE DISSPLA GRAPHICS SYSTEM
      C
          200 CALL BGNPL(1)
              CALL INCH30
```

```
      XPAGE=20.0
      YPAGE=13.0
      CALL PAGE(XPAGE,YPAGE)
      XORG=2.0
      YORG=1.0
      CALL PHYSOR(XORG,YORG)
      XSIZE=XPAGE-XORG-1.0
      YSIZE=YPAGE-YORG-2.0
      CALL TITLE(' ',1,' ',1,LYNAM1,100,XSIZE,YSIZE)
      CALL COMPLX
      CALL HEADIN(LTITLE,100,4,1)
      XLEFT=0.0
      XSEGM=(XSIZE/FLOAT(NPTS))*12.0
      XRIGHT=XLEFT+XSEGM
      YPOS=-0.4
      CALL HEIGHT(0,21)
      NYEAR=(NPTS/12)+1
      IF(((NYEAR-1)*12) .EQ. NPTS) NYEAR=NYEAR-1
      LYEAR=1975+NYEAR-1
      DO 300 J=1975,LYEAR
  250 ENCODE(LABELX,1010)J,IDOLLR
 1010 FORMAT(I4,A1)
      AX=XMESS(LABELX,100)
      IF(AX .GT. XSEGM) GO TO 400
      XPOS=XLEFT+((XSEGM-AX)/2.0)
      CALL MESSAG(LABELX,100,XPOS,YPOS)
      XLEFT=XLEFT+XSEGM
      XRIGHT=XLEFT+XSEGM
      IF(XRIGHT .GT. XSIZE) XSEGM=XSIZE-XLEFT
  300 CONTINUE
      CALL MESSAG(LINTER,100,11.0,2.4)
      CALL MESSAG(LBATCH,100,13.3,5.3)
  400 CALL RESET('COMPLX')
      CALL HEIGHT(0,14)
      CALL ANGLE(90.0)
      CALL MESSAG(LMEC,100,15.7,7.0)
      CALL RESET('ANGLE')
      CALL MESSAG(LADJST,100,14.7,9.0)
      CALL VECTOR(13.3,9.7,14.5,9.7,1323)
      CALL AXSPLT(YMIN,YMAX,YSIZE,YORGIN,YSTEP,YAXIS)
      NSEGY=(YMAX-YORGIN)/YSTEP
      IF((YORGIN+(YSTEP*FLOAT(NSEGY))) .LT. YMAX) YMAX=YORGIN+(YSTEP*FLO
     1AT(NSEGY+1))
      CALL XNONUM
      CALL GRAF(0.0,12.0,XMAX,YORGIN,YSTEP,YMAX)
      CALL GRID(1,1)
      CALL CURVE(X,AINTER,NPTS,0)
      CALL CURVE(X,TOTAL,NPTS,0)
      CALL YGRAXS(0.0,10.0,100.0,YAXIS,LYNAM2,100,-0.75,0.0)
      CALL GRID(0,1)
      CALL CURVE(X,PERCNT,NPTS,0)
```

```
C
C     DISABLE DISSPLA GRAPHICS SYSTEM
C
      CALL ENDGR(1)
      CALL ENDPL(0)
      CALL DONEPL
C
C     TERMINATE RUN
C
  999 CALL EXIT
      END
```

AD-A062 478 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 9/2
GRAPHICS IN THE CORPS. PROCEEDINS OF THE COMPUTER GRAPHICS COLL--ETC(U)
1978 J M JONES, R L HALL, N RADHAKRISHNAN

UNCLASSIFIED NL

2 OF 5
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A062478

Comparison of using Calcomp Graphics and Disspla Graphics

Calcomp	Disspla
3 SRU's	24.2 SRU's
116 Source Cards (Excluding Comments)	86 Source Cards (Excluding Comments)
38 Disk Pages for Executable Module	72 Pages for Executable Module
18 Seconds to Run	63 Seconds to Run
	2850 Vectors Generated at $1.75 per 1000 Vectors ($4.98 Surcharge)

```
C234567--0----5----0----5----0----5----0----5----0----5----0----5----01
C       COVER FOR DISSPLA PRESENTATION AT GRAPHICS COLLOQUIUM
C        LAMBRECHT   1978 JULY 24
        DIMENSION IPK(500),ANG(2)
        DATA ANG/45.,-45./
        CALL BGNPL(0)
       CALL NOBRDR
        XPAGE = 8.5
        YPAGE = 11.0
        CALL PAGE(XPAGE,YPAGE)
        CALL PHYSOR(0.,0.)
        CALL TITLE(' ',0,' ',0,' ',0,8.0,10.5)
       CALL FRAME
        CALL LOGO1
        CALL HEIGHT(1.2)
        CALL SHDCHR(ANG,2,.1,-1)
        CALL LINESP(5.0)
        AX = XMESS('DI"PLAS',100)
        XPOS = (8.0 - AX) / 2.
        CALL MESSAG('DI"PLAS',100,XPOS,8.3)
        CALL MX1ALF('SCRIPT','(')
        CALL MX2ALF('L/CSCRIPT',')')
        CALL MX3ALF('ITALIC','*')
        CALL MX4ALF('L/CITALIC','+')
        CALL MX5ALF('STANDARD','&')
        CALL MX6ALF('L/CSTD','#')
        CALL COMPLX
        CALL HEIGHT(.42)
        CALL LINESP(3.)
       MAXLIN=LINEST(IPK,500,30)
        CALL LINES('A P)RESENTATION (G)IVEN (B)Y$',IPK,2)
        CALL TRIPLX
        CALL HEIGHT(.4)
        CALL LINES('&JOHN N. LAMBRECHT$',IPK,3)
        CALL HEIGHT(.3)
        CALL LINES('&NASHVILLE ENGINEER DISTRICT$',IPK,4)
        CALL COMPLX
        CALL LINES('A)T (T)HE$',IPK,5)
        CALL TRIPLX
        CALL HEIGHT(.28)
        CALL LINES('&COMPUTER GRAPHICS COLLOQUIUM$',IPK,6)
        CALL HEIGHT(.21)
        CALL LINES('*WATERWAYS EXPERIMENT STATION$',IPK,7)
        CALL LINES('*V+ICKSBURG, *M+ISSISSIPPI*$',IPK,8)
        CALL LINES('1 - 3 AUGUST 1978$',IPK,9)
        X = XSTORY(IPK,9)

        Y = YSTORY(IPK,9)
        X = (8.0 - X) / 2.
        Y = (8.9 - Y) / 2.
        CALL STORY(IPK,9,X,Y)
       CALL ENDGR(1)
        CALL ENDPL(0)
        CALL DONEPL
        STOP
        END
```

Los Alamos Scientific Lab. Los Alamos, New Mexico 87545	CDC 6600 Cyber 73 Kronos	Tektronix; FR80; SC4020; Zeta; Calcomp
3M St. Paul, Minn. 55101	DEC 20	Tektronix; Diablo; HP2648
Martin Marietta Denver, CO 80201	CDC 6500 Scope 3.4 FTN,RUN	Calcomp; Tektronix; FR80
McDonnell Douglas Automation (McAuto)	Cyber 74 Kronos	Calcomp; FR80; Tektronix; Xynetics; Gould; Betacom; SD4020
Monsanto Company 800 N. Lindbergh Blvd. St. Louis, Missouri 63166	IBM 370-168 VS2;	Calcomp; Tektronix; Printer; Versatec
	DEC 10	Calcomp; Tektronix
NASA AMES Moffett Field, CA 94035	CDC 7600 Scope 2.0; IBM 360 TSS	COMP80; Tektronix; Zeta; Calcomp
NASA JSC Houston, TX 77058	(2) UNIVAC 1110	Tektronix; COMP80; Hazeltine; Calcomp
National Library of Medicine 8600 Rockville Pike Bethesda, MD 20014	IBM 370 OS	Tektronix; Zeta
National Research Council Ottawa, Ontario	IBM 360-67 TSS	
Navoceano NSTL Station, MS	UNIVAC 1108 EXEC 8	Tektronix; Xynetics; Calcomp
*National CSS		
Norwalk, Conn. San Francisco	IBM VP-CSS, Amdahl	Calcomp; Zeta; Tektronix; Gencom; Betacom; FR80; Houston Instrument
DWTNSRDC David W. Taylor Naval Ship R&D Center Bethesda, MD	CDC 6700 CDC 6600 Scope 3.4.3	Calcomp; SC4020; SD4060; Tektronix; [illegible]

NOSC Naval Ocean Systems Center San Diego, California 92152	UNIVAC 1110 U5,ASCII	Tektronix; Calcomp; Comtal 8300
NRL Naval Research Lab Washington, D. C.	TI ASC	Calcomp; Tektronix; Zeta; SC4020
NUSC Naval Underwater Systems Ctr. New London, Connecticut	UNIVAC 1108	FR80; Tektronix; Calcomp; Printer
Naval Weapons Center China Lake, California 93555	UNIVAC 1110 U5, ASCII	COMP80; Tektronix; Gerber; HP7202; Calcomp
NOAA Boulder, Colorado	CDC 6600 Kronos	Tektronix; Computek; Calcomp; Zeta; CDC 2250. FR80; Houston Instrument
Pan Canadian Petroleum Calgary,Alberta	Honeywell 6000 GCOS	
PTT (Dutch Post Office) Leidschendam, Holland	UNIVAC 1110 Exec 8	Houston Instrument
Raytheon Bedford, Massachusetts	CDC 6700 Cyber 74 NOS 1.2	Tektronix; Calcomp; Gerber; Xynetics; Zeta; Betacom; Gould; GSI
RCA Aegis Moorestown, NJ 08057	DEC 20	Tektronix; Calcomp; HP7202A
RCA Cherry Hill, NJ	IBM 370 VM/CMS	Calcomp; Zeta; Tektronix; H. P. ; Versatec
REAP Bismark, North Dakota	Harris 140	Zeta; Tektronix
RECAU (Univ. Of Aarhus) Aarhus,Denmark	Cyber 173 NOS-Kronos	
Rockwell Int'l Downey, CA 90241	Cyber 175 NOS/BE	SC4020; FR80; Tektronix; Calcomp
SAI La Jolla, CA	DEC 10	Calcomp; Tektronix; Versatec

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NASHVILLE ENGINEER DISTRICT

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COMPUTER GRAPHICS APPLICATIONS IN ENGINEERING

For Presentation

At

COMPUTER GRAPHICS COLLOQUIUM

1 August - 3 August 1978

Vicksburg, MS

Written by

William D. McDonald, P.E.

Chief, Engr Prog Br

NED ADP Center

ACKNOWLEDGEMENT

PLOT-10

Development of computer graphics in the Rock Island District has been a team effort involving the users and most of the people in the District's ADP Center. In the presentation of this paper, however, special mention should go to Greg Kelly and Lee Lister. Greg wrote many of the applications described in this paper while Lee was responsible for the development of the basic software such as the graphical input routines. Also, the majority of solutions to the problems described were suggested by one or the other.

[redacted]

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INTRODUCTION

The Rock Island District covers about 58,000 square miles in the states of Iowa, Illinois, Missouri, Minnesota and Wisconsin. The major river basins which drain into the Mississippi within the District include the Rock River in Wisconsin and Illinois and the Cedar, Iowa, Skunk and Des Moines Rivers in Minnesota, Iowa and Missouri. The major missions of the District include flood control, recreation and navigation.

Scientific and engineering computer programs have been used heavily in support of the missions of the Rock Island District. The list of available programs for the District numbers about 650. These programs are in addition to those available through the ECPL and other outside sources. The programs vary from short time savers such as riprap computation with one page of output to simulation of tandem reservoirs which produces 3000 pages of output. Many of the problems also include graphical output either on a graphics terminal or an off-line plotter.

DISTRICT COMPUTER CAPABILITIES

In order to process the workload, the ADP Center has established communications with six large computers. These are a CDC system owned by Boeing Computer Services in Seattle, Washington; WES's G-635 in Vicksburg, Mississippi; Honeywell Information System's H-6000 in Minneapolis, Minnesota; a Honeywell 66/80 owned by the US Civil Service Commission at Macon, Georgia; Lawrence Berkeley Laboratory's CDC 7600 at Berkeley, California; and United Computing System's CYBER 175 in Kansas City, Missouri. Approximately 90% of the engineering computer work is done on Boeing's system.

The communications network presently consists of a 4800 baud dedicated line to Boeing Computer Services' multiplexor in Chicago, a 2400 baud dedicated line to North Central Division, a 4800 baud dial-up line and a 2000 baud dial-up line. Low-speed communications are handled by a local access to Boeing's communication network located within the District's ADP Center. Communications to other systems is handled by the FTS Network.

Off-line graphics is presently being done using a Gerber Model 43 SUPERplotter. This plotter has multiple pen capability, local symbol generation and a maximum speed of approximately 30 inches/second.

In the District there are five major user areas involved in computer applications. Based on computer use for the last fiscal year, about 44% of the S&E applications involved hydraulics and hydrology; reservoir regulation involved 14%; soil mechanics involved 20%; 13% of the use was for design and 5% was used for surveying. Graphics applications are used heavily in each of these areas.

It has been the requirement of the ADP Center to provide immediate access to low-speed terminals for the users. The four major users have low-speed terminals located in their offices. Additional terminals are available in the ADP Center.

Also, the Hydraulics Branch, the Design Branch and the ADP Center have Tektronix 4014 graphics terminals. These terminals all have Tektronix digitizing tablets (Model 4954) and hard copy units (Model 4631). The Tektronix located in the ADP Center also has a floppy disc (Tektronix Model 4921) for off-line digitization and storage.

THE USE OF COMPUTER GRAPHICS IN THE ROCK ISLAND DISTRICT

The Rock Island District became involved in computer graphics in October 1968 when the District obtained a Calcomp drum plotter. This sufficed for computer graphics applications for some years. As the off-line graphics workload increased in size and range of application the District upgraded to the present Gerber plotter.

When interactive processing became available in the Corps, its advantages in engineering soon became apparent. There are many problems in engineering with a small amount of input and output that can be most efficiently solved by immediate response and interaction between the machine and the user.

There is another class of problem, however, which could be efficiently solved interactively but the output to be analyzed may be considerable. In these problems, *interactive computer graphics can be very useful.* The output is reduced to a picture, and many decisions and solutions can be quickly obtained from the graph.

Other problems which lend themselves to graphic applications are those where the input data is already in graph form such as maps, cross-sections, rating curves, etc. The use of graphical input devices such as Tektronix tablets saves having to convert the graphical data to digital data in order to enter it into the computer.

GRAPHICS SOFTWARE

Basically, four groups of graphics software are presently available to the District. They are: Gerber PSP (with in-house developed software to provide Calcomp compatibility), Graphics Compatibility System, Tektronix

PLOT-10 Advanced Graphing II and Boeing Interactive Graphics System. They all provide Fortran callable subroutines to interface with graphics devices.

Presently, all of the off-line plotting programs use the Gerber PSP software. The Boeing Interactive Graphics System is not being used because of its system dependence. Interactive graphics written in the District use either ADVANCED GRAPHING II (AGII) or Graphic Compatibility System (GCS), depending on the application.

INTERACTIVE GRAPHICS

Rock Island was one of the first Districts to make use of interactive computer graphics. The District obtained a Tektronix 4012 terminal in June 1976 while running programs at both WES (Honeywell G-635) and Computer Sciences Corporation (Univac 1108). At the time, GCS was only available at WES while AGII and Tektronix Calcomp preview routines were available on the Univac. It was decided to develop graphics on the Univac since there was a major drawback to running graphics at WES -- communications. On a printed output some "garbage" will still produce a readable product. Occasional "garbage" received during graphical output generally results in disaster.

Part of the PLOT-10 software includes Calcomp preview routines. These were tried initially and are still used to test off-line plotter programs. It was found to be unacceptable for most interactive applications, however, since (1) it was slow (characters are drawn rather than printed) and (2) it did not have all the capabilities such as windowing. Therefore, AGII was used for most of the initial graphics programs.

PROBLEMS ENCOUNTERED WITH AGII

The initial problem encountered with AGII was that the version available on Computer Sciences' machine did not match the PLOT-10 documentation. Many of the calling sequences to the subroutines were different and the District was unable to obtain documentation or even a list of the new calling sequences. Most of the calling sequences were determined by combining a knowledge of variables that would likely be needed by each subroutine with a trial and error approach. This lack of support for PLOT-10 software has continued, particularly in the use of the graphics tablet.

Another problem encountered seems to be common to much of the available graphics software. That is, many of the higher level subroutines do not fit the application. An example of this is automatic scaling (few engineers care to work with a scale of 1 inch = 384 cubic feet/second). This necessitates using the lower level routines to tailor the program to the needs of the user. While this is a satisfactory solution, it makes the programming more difficult.

In developing the graphic input routines, a problem caused by the operating system used by Computer Sciences Corporation was discovered. Data off the tablet is sent as a header character followed by five five-bit bytes containing the location (12 bit operation) followed by a carriage return. The header becomes one of the following depending on the point entered:

GS (ASCII 29) -- First point transmitted

SUB (ASCII 26) -- Any following point

When the cursor leaves presence the status word is sent instead of a header character.

By testing the header character it then becomes possible to determine if the point is the first point of a line, an intermediate point, or the last point. The problem on Computer Sciences was that both GS and SUB were illegal characters and entered the computer as "?" (ASCII 63). It became necessary to examine a combination of the first three bytes to determine if the point was first, intermediate, or last.

An additional problem occurred in the tablet routine when the District converted to Boeing Computer Services. The routine is designed to print some information on the screen, rearm the tablet and sound the bell to signal the user to input a new point. This information was returned to the terminal but not necessarily in the same order. This was solved by forcing an ENDFILE on OUTPUT.

Although this discussion has centered on problems encountered by the District while using AGII it seems likely that these problems are common to other graphics software.

GRAPHICS APPLICATIONS

Presently, the District has about 100 programs which use computer graphics, many of which are interactive. The following is a brief description of the most used interactive graphics programs written in the Rock Island District.

a. Interior Drainage Analysis --

A system of programs was written to help analyze interior drainage. The programs are related through a series of files. Each

program produces a graphical output of results and the system may be interrupted at any time to make changes in the assumed parameters. The programs include: (1) development of unit hydrograph by Clarks method which produces a plot of the unit graph; (2) rainfall applied to a unit graph which produces a plot of rainfall, unit graph and hydrograph; and (3) pond routing by modified puls method which produces a plot of inflow hydrograph, outflow hydrograph and pond elevation.

b. HEC2 Data Load --

This program utilizes the digitizing tablet to produce HEC2 data decks from cross-section plots. Input data such as titles and special bridge cards are entered from the keyboard. Cross-sections are entered from the tablet and GR and parts of the X1 cards are generated by the program. For one project this program was used to enter 80 miles of cross-sections in three man-weeks. The estimated savings was $20,000.

c. Rating Curves by Normal Depth Computation using Mannings Equation --

This program computes water surface elevation given flow, flow given water surface elevation, or a rating curve at a given cross-section. The cross-section may be entered from the keyboard or the tablet. The cross-section and rating curve may be plotted.

d. Slope Stability Analysis Pre and Post Processors --

These two graphics programs are used to interface three off-line plotting programs to a slope stability analysis program. The pre-processor generates an on-line plot of the embankment configuration for a check of the data. It also produces input files to the analysis

program and plotting programs. The post-processor plots the range of failure surfaces and produces an off-line plot of the stability plate utilizing the results of the analysis.

e. Emergency Operations Flood Hydrograph Plot --

This program is used to quickly transfer information to the Emergency Operations Center during flood operations. Projected flood hydrographs are entered into the system by the Hydraulics Branch and the information may be retrieved for any station at the EOC. During flood emergencies, a Tektronix 4014 is moved to the Emergency Operations Center.

f. Basin Rainfall Map --

This program plots a map of the District and rainfalls at each rainfall reporting station in the District. It has windowing capability so that the field of view may be narrowed to a particular basin. The station locations used in the program were entered from the digitizing tablet. The program also interfaces with the AUTOMAP II contour package to produce rainfall isohyetal plots on the high speed printer.

The District also makes use of graphics programs written at WES. In particular, STRUPUT and FEM pre and post processor for seepage analysis.

OFF-LINE DIGITIZING

Recently, the District acquired a Tektronix flexible disc unit. This has made it possible to digitize and store data off-line to be later transmitted to the computer. This results in reduced connect time, reduced digitizing time and reduced transmission errors.

The disc is Model 4921 with one disc unit. The disc is divided into 64 tracks of 32 sectors each. Each sector is capable of storing 128 eight-bit bytes for a total of 262,144 bytes/disc.

COMPARISON OF AGII AND GCS

Some relative advantages and disadvantages of each system were determined based on the experience of the District.

The advantages of AGII include:

1) Flexibility - through the use of the basic routines it is possible to perform many tasks more easily than using higher level routines.

2) District has more experience using AGII.

3) The software is available for most mainframes.

4) Calcomp preview routines.

The disadvantages of AGII include:

1) Harder to program.

2) Lack of support.

3) Lack of higher level subroutines for curve fitting, math, etc.

The advantages of GCS include the following:

1) Relatively easy to use.

2) Good support.

3) Math and other higher level subroutines are available.

4) Training available.

5) Capable of reproducing interactive plot off-line.

The major disadvantage to GCS is the fact that it is not running on all the computers that the District is using.

PRESENT AND FUTURE GRAPHICS DEVELOPMENT

Within the last six months, the use of graphics and particularly graphical input has increased significantly. This is due largely to the Crow Creek Extended Flood Plain Information Report which the District is preparing. This study is one of eleven pilot studies for expanded flood plain reports. The methodology makes use of a large data base of spatially grided data. The input to the data bank comes from maps and the output is produced as a map, either on the printer or the plotter.

The Rock Island District aided HEC in making the AUTOMAP and AUTOPLOT programs available on Boeing's computer system. Since then the District has been developing software to integrate the Tektronix tablet and disc and the Gerber plotter with the HEC-SAM programs.

Basically, the building of the data base is done as follows: The data from the map is digitized off-line and stored on disc. This information is then transferred to a file on the computer. A program then reads the data and generates an input file for either AUTOMAP or AUTOPLOT at the desired scale. The selected program is then run and checked for data errors. Any errors are generally corrected by digitizing parts of the map again or by a special purpose program. Each layer of the data base is then produced by running AUTOMAP with the write option on. (NOTE: The use of this spatial analysis method and AUTOMAP and AUTOPLOT is documented in several HEC publications.)

This method appears to be very efficient for this type of study. The Crow Creek Basin covers about 18 square miles and contains about 50000 grid cells (approximately ¼ acre resolution). The data bank will have 12 to 14 layers of which 9 have been or will be digitized. Some of the other layers will be generated automatically from digitized data. The data that has been digitized includes subbasin layout, soil types, habitat and habitat quality. That data which is yet to be digitized includes present land use, alternative future land uses, archeological and cultural sites, damage reaches and reference flood elevations. Data with few polygons, such as subbasins which had 12, can be digitized and checked in a few hours. The soil types which included several hundred polygons required about two days.

It is anticipated that the final output for the report will be done using the AUTOPLOT and GRIDPLOT programs on the Gerber plotter. The output will consist of plotted maps of flooded area, choice recreation sites, subbasin delineation, etc. The maps will be plotted on orthophoto mosaics of the basin.

SUMMARY

The use of computer graphics has greatly improved in recent years and it is likely that it is just beginning. The experience of the Rock Island District has shown considerable success in the development of graphics programs, while at the same time producing an uncounted number of headaches.

In recent years, water resources development has become increasingly complex, with more inputs, more rigorous solutions and more alternatives to be considered. The complexity and the increased input and output will

provide the impetus for future graphics development. Continued support of computer graphics is necessary for the Corps to continue solving the water resource problems of the country.

GPLOT

GPLOT

By: Kline Bentley

At Jacksonville, we have a library of graphics, subroutines and functions called "GPLOT." The handout you have, or should have, is the internal documentation taken from the source code itself and contains the routine name, calling procedures and arguments, and a line or two describing the routine's purpose. The routines on the handout are separated into two sets. The first set is composed of user routines, and the second set is composed of internal routines, i.e., those routines that the user would not ordinarily be concerned with in a graphics application, but are nevertheless needed and used for support. There is a document on GPLOT available at the District Office which goes into more detail and gives examples of use. The whole package contains approximately 100 user callable subroutines. Some are old, and some are new. For example, subroutine SYMBOL was converted from a Calcomp assembly language routine over ten years ago and still contains BCD to ASCII cross reference tables. The source consists of about 3800 lines of code, all in FORTRAN; however, some of the routines contain code particular to DEC's PDP 11/70 FORTRAN. This is primarily in the area of storage allocation on a byte by byte basis.

This is a summary extract of the author's presentation to the Corps Graphics Colloquium at WES, 1-3 Aug 78.

Mr. Bentley is a Mathematician assigned to the Water Management Section, USAEDistrict Jacksonville, FL 32201.

Some of the user routines will be converted to BASIC later this year or early next year, for use on a Hewlett Packard 9845 desk-top computer, which the District has on order to support Reservoir Regulation. The specific graphics hardware to be used will be the HP 9372 plotter and HP 9874 digitrizer. AS GPLOT now stands, the principal hardware used is the Textronix 4014 terminal, 4954 graphics tablet, and a Gerber 4343 off-line plotter.

The major uses of graphics at Jacksonville include processing and presentation of hydrographic survey data, retrieval and frequency analysis of time history records by Flood Plain Management, economics analysis, and record keeping and report preparation of Reservoir Regulation activities.

The following are sample output from GPLOT:

1. Hydrographic Survey Applications

   (a) Raw data from tablet
   (b) Step 1 processing (conversion to user units)
   (c) Channel limits overlay for previewing
   (d) Final output

2. Frequency Analysis

   (a) Time series presentations

3. Economics

(a) Initial input curves

(b) Intermediate processing and transformations

(c) Final $ damage plots

4. Reservoir Regulation

(a) Lake Okeechobee plots

5. Summary

(a) GDEMO slides

(b) Log and simi-log grids

(c) 3-D capability (without hidden lines)


JACKSONVILLE
GPLOT
DISTRICT
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```
USER SUBROUTINE ALPHA

        PURPOSE: TO SET ALPHA MODE ON THE TEKTRONIX 4014.

        CALL: CALL ALPHA

        ARGUMENTS:
                NONE

        REMARKS:
                THE 4014 MUST BE IN ALPHA MODE TO TYPE
                ON THE TERMINAL.
```

```
USER FUNCTION LEAP

        PURPOSE: TO DETERMINE LEAP YEARS

        CALL: V=LEAP(IYR)

        ARGUMENTS:
                IYR       YEAR
                V IS RETURNED = 1 IF YEAR
                IS A LEAP YEAR.
                IF YEAR IS NOT A LEAP YEAR
                V IS RETURNED = 0.

        REMARKS:
                IF YEAR IS LESS THAN 1000 YEAR IS ASSUMED
                TO BE IYR+1900.
```

```
USER SUBROUTINE AREAS

        PURPOSE: TO CALCULATE AREA OF AN IRREGULAR POLYGON

        CALL: CALL AREAS(X,Y,N,AREA)

        ARGUMENTS:
                X,Y       SET OF POINTS DEFINING BOUNDARY OF POLYGON
                N         NUMBER OF POINTS IN X,Y SET
                AREA      RETURNED AREA

        REMARKS:
                N/A
```

U 1

```
------------------------------------------------------------

USER SUBROUTINE BEGIN

        PURPOSE: TO SELECT THE OUTPUT DEVICE AND INITILIZE
                 THE GRAPHICS PACKAGE.

        CALL: CALL BEGIN(DEV)

        ARGUMENTS:
                DEV      THE OUTPUT DEVICE NAME (TEKTRONIX OR GERBER)

        REMARKS:
                THE DEVICE NAME MAY ENTER AS A LITTERAL OR
                A BYTE VARIABLE.

                THIS SUBROUTINE SETS THE FOLLOWING CONDITIONS:
                1. THE SCALE IS SET TO 1" = 1"
                2. THE ORIGIN IS SET TO (0,0)
                3. THE SCREEN IS ERASED (TEKTRONIX)
                4. THE TERMINAL MODE IS SET TO GRAPHICS (TEK)
                5. AN EOF MARK IS WITTEN ON TAPE (GERBER)
                6. THE PLOT SEQUENCE NUMBER IS SET TO 1 (GERBER)

------------------------------------------------------------

USER SUBROUTINE BELL

        PURPOSE: TO RING TERMINAL BELL

        CALL: CALL BELL

        ARGUMENTS:
                NONE

        REMARKS:
                N/A

------------------------------------------------------------

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```

USER SUBROUTINE CENTER

PURPOSE: TO DRAW ALPHANUMERIC CHARACTERS CENTERED ON A POINT

CALL: CALL CENTER(X,Y,H,IBCD,ANGLE,N)

ARUGMENTS:

```
X,Y      THE POINT ABOUT WHICH THE CHARACTER STRING
         IS TO BE DRAWN
H        THE HEIGHT OF THE CHARACTER STRING
IBCD     AN ARRAY CONTAINING THE ASCII CHARACTERS
ANGLE    THE ANGLE AT WHICH THE STRING IS TO BE DRAWN
N        THE NUMBER OF CHARACTERS TO BE DRAWN
```

REMARKS:

THIS ROUTINE COMPUTE THE CENTER OF A ASCII CHARACTER STRING AND DRAWS ONE HALF OF THE STRING ON EACH SIDE OF POINT X,Y. DO NOT PLOT SPECIAL CENTERED WITH THIS SUBROUTINE.

USER SUBROUTINE CIRCLE

PURPOSE: TO DRAW A CIRCLE

CALL: CALL CIRCLE(X,Y,RADIUS)

ARGUMENTS:

```
X,Y      COORDINATES OF CIRCLE CENTER
RADIUS   RADIUS OF CIRCLE IN INCHES
```

REMARKS:

N/A

USER SUBROUTINE COPY

PURPOSE: TO PRODUCE HARD COPY OF SCREEN CONTENTS
ON TEXTRONIX 4631 HARD COPY UNIT

CALL: CALL COPY

ARGUMENTS:

NONE

REMARKS:

N/A

H 3

****

USER SUBROUTINE CURSOR

PURPOSE: TO GET THE COORDINATES OF THE TEXTRONIX CURSOR

CALL: CALL CURSOR(X,Y,JCH)

ARGUMENTS:

X,Y	RETURNED COORDINATES OF CURSOR
JCH	RETURNED CHARACTER ENTERED AT TERMINAL

REMARKS:

RETURNED CHARACTER IS UPPER CASE

****

USER SUBROUTINE DASH

PURPOSE: TO DRAW A SHORT DASHED LINE.

CALL: CALL DASH(X,Y)

ARGUMENTS:

X,Y	THE COORDINATES TO WHICH THE LINE IS DRAWN.

REMARKS:

N/A

****

USER SUBROUTINE DASHLN

PURPOSE: TO GENERATE DASHED LINES

CALL: CALL DASHLN(X,Y,DASH,SPACE,NUM)

ARGUMENTS:

X,Y	COORDINATES TO WHICH THE DASHED LINE IS DRAWN
DASH	THE LENGHT OF THE LONG DASH
SPACE	THE LENGTH OF THE SHORT DASH AND SPACE BETWEEN DASHES
NUM	NUMBER OF SHORT DASHES BETWEEN LONG DASHES

REMARKS:

N/A

****

USER SUBROUTINE DELAY

PURPOSE: TO TEMPORARILY HOLD A DRAWING ON THE TEXTRONIX 4014 SCREEN

CALL: CALL DELAY

ARGUMENTS:
NONE

REMARKS:
CAUSES ABOUT 30 SECOND DELAY

USER SUBROUTINE DOTDSH

PURPOSE: TO DRAW A DOT-DASHED LINE.

CALL: CALL DOTDSH(X,Y)

ARGUMENTS:
X,Y THE COORDINATES TO WHICH THE LINE IS DRAWN.

REMARKS:
N/A

USER SUBROUTINE DOTTED

PURPOSE: TO DRAW A DOTTED LINE

CALL: CALL DOTTED(X,Y)

ARGUMENTS:
X,Y THE COORINATES TO WHICH THE LINE IS DRAWN.

REMARKS:
N/A

U S

USER SUBROUTINE DRAW

PURPOSE: TO DRAW A LINE TO THE GIVEN LOCATION.

CALL: CALL DRAW(X,Y)

ARGUMENTS:
X,Y THE COORDINATES TO WHICH THE LINE IS TO BE DRAWN.

REMARKS:
N/A

USER SUBROUTINE ERASE

PURPOSE: TO ERASE THE TEXTRONIX SCREEN

CALL: CALL ERASE

ARGUMENTS:
NONE

REMARKS:
N/A

USER SUBROUTINE FAT

PURPOSE: TO SET DEFOCUSED BEAM MODE ON TH 4014.

CALL: CALL FAT

ARGUMENTS:
NONE

REMARKS:
N/A

USER SUBROUTINE FIGURE

PURPOSE: TO DRAW AN N SIDED REGULAR POLYGON

CALL: CALL FIGURE(CX,CY,SIDE,FIG,ARC,ANGLE)

ARGUMENTS:

```
        CX,CY     COORDINATES OF CENTER OF POLYGON
        SIDE
        FIG
        ARC
        ANGLE
```

REMARKS:

N/A

USER SUBROUTINE FIND

PURPOSE: TO CONVERT COORDINATES IN INCHES TO USER UNITS

CALL: CALL FIND(X,Y,XO,YO)

ARGUMENTS:

```
        X,Y       COORDINATES FROM SUBROUTINE CURSOR
                  IN INCHES
        XO,YO     RETURNED COORDINATES IN USER UNITS
```

REMARKS:

N/A

USER SUBROUTINE FIND1

PURPOSE: SAME AS FIND EXCEPT RETURNED X COORDINATE IS MONTH, DAY, AND YEAR FOR USE WITH SUBROUTINE GRIT(GRID WITH CALENDAR TIME NOTATION)

CALL: CALL FIND1(X,Y,IM,ID,IY,YO)

ARGUMENTS:

X,Y	COORDINATES FROM SUBROUTINE CURSOR IN INCHES
IM,ID,IY	RETURNED MONTH,DAY,YEAR
YO	RETURNED Y COORDINATE IN USER UNITS

REMARKS:
FOR USE ON CALENDAR GRIDS OF RESONABLE LENGTH ONLY(5 YEARS OR LESS FOR EXAMPLE)

USER SUBROUTINE FINISH

PURPOSE: TO DUMP PLOT BUFFER AND REWIND PLOT TAPE

CALL: CALL FINISH

ARGUMENTS:
NONE

REMARKS:
N/A

USER SUBROUTINE GRAPH

PURPOSE: TO SET GRAPHICS MODE ON THE TEKTRONIX 4014.

CALL: CALL GRAPH

ARGUMENTS:
NONE

REMARKS:
N/A

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USER SUBROUTINE GRID

PURPOSE: TO PLOT LINEAR, LOG OR LOG-LINEAR GRIDS.

CALL: CALL GRID(X,Y,NX,NY)

ARUGMENTS:

```
                X,Y      LENGTH OF X AND Y AXIS.
                NX,NY    NUMBER OF DIVISIONS ON X AND Y AXIS.
```

REMARKS:

GRID WILL BE DRAWN AT CURRENT ORIGIN.
SEE SETGRD FOR GRID OPTIONS.
DEFAULT IS A SOLID LINE GRID, LINEAR BOTH AXIS.

USER SUBROUTINE GRID1

PURPOSE: TO DRAW A LINEAR PLOTTING GRID

CALL: CALL GRID1(X,Y,NX,NY)

ARUGMENTS:

```
        X,Y      LENGTH OF X AND Y AXIS
        NX,NY    NUMBER OF DIVISIONS ON X AND Y AXIS
```

REMARKS:

GRID WILL BE DRAWN AT CURRENT ORIGIN

GRID1 INDICATES DIVISIONS BY MARKS ON
EDGE OF GRID

USER SUBROUTINE GRID2

PURPOSE: TO DRAW A LINEAR PLOTTING GRID.

CALL: SAME AS GRID1

ARUGMENTS:

SAME AS GRID1

REMARKS:

GRID2 INDICATES DIVISIONS BY MARKS
AT GRID INTERSECTIONS

USER SUBROUTINE GRIDS

PURPOSE: TO PROVIDE AN QUICK USE ROUTINE TO DRAW GRIDS, SCALE DATA, PLOT DATA AND WRITE TITLES.

CALL: CALL GRIDS(X,Y,N,LABT,LABX,LABY)

ARGUMENTS:

X,Y	DATA ARRAYS TO BE PLOTTED
N	NUMBER OF DATA POINTS
LABT	MAIN TITLE
LABX	X AXIS TITLE
LABY	Y AXIS TITLE

REMARKS:

THIS ROUTINE WILL DRAW A GRID, LABEL THE GRID, SCALE THE DATA AND PLOT THE DATA. USE SETGRD FOR LOGS.

USER SUBROUTINE GRIDT

PURPOSE: THIS ROUTINE COMPUTES PROPER LABEL VALUE LINKAGE FROM SUBROUTINE GRIT WHEN A FOREIGN ARRAY OF TIME VALUES OTHER THAN THE NUMBER OF DAYS IS SUPERIMPOSED OVER A CALANDER TIME GRID. THE LINKAGE VALUES INITIATE THE ROUTINES PLTS AND OPLT.

CALL: CALL GRIDT(AMAXX,AMINX,AMXLBL,AMNLBL)

ARGUMENTS:

AMAXX	MAXIMUM VALUE IN FOREIGN ARRAY
AMINX	MINIMUM VALUE IN FOREIGN ARRAY
AMXLBL	RETURNED MAXIMUM LABEL
AMNLBL	RETURNED MINIMUM LABEL

REMARKS:

THIS ROUTINE CAN BE USED ONLY AFTER THE ROUTINE GRIT IS CALLED.

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```
-------------------------------------------------------------------

USER SUBROUTINE GRIT

        PURPOSE: TO GENERATE PLOTTING GRID WITH CALENDAR
                 TIME NOTATION ON X AXIS

        CALL: CALL GRIT(X,Y,NY)

        ARGUMENTS:
                 X,Y      LENGTH OF X AND Y AXIS IN INCHES
                 NY       NUMBER OF DIVISIONS ON Y AXIS

        REMARKS:
                 THE BEGIN AND END DATES GENERATED DEPENDS ON
                 THE BEGIN AND END DATES CURRENTLY IN
                 SUBROUTINE GTIME

-------------------------------------------------------------------

USER SUBROUTINE GTIME

        PURPOSE: PROVIDES STORAGE OF BEGIN AND END DATES
                 FOR SUBROUTINES GRIT AND FIND1

        CALL: CALL GTIME(IMT,IDT,IYT,IFL)

        ARGUMENTS:
                 IMT      MONTH(1 TO 12)
                 IDT      DAY(1 TO 28,29,30,31)
                 IYR      YEAR
                 IFL      STORE OR RETURN INDICATOR AS FOLLOWS:
                 IFL=1    STORE BEGIN DATE
                 IFL=2    RETURN BEGIN DATE
                 IFL=3    STORE END DATE
                 IFL=4    RETURN END DATE
                 IFL=5    STORE BEGIN DATE FOR FIND1
                 IFL=6    RETURN BEGIN DATE FOR FIND1
        REMARKS:
                 N/A

-------------------------------------------------------------------
```

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USER SUBROUTINE HOLD

PURPOSE: TO HOLD A DRAWING ON THE SCREEN
UNTIL A CARRAGE RETURN IS TYPED

CALL: CALL HOLD

ARGUMENTS:
NONE

REMARKS:
N/A

USER SUBROUTINE LABELX

PURPOSE: TO LABEL AND SET SCALEING ON X AXIS
OF LINEAR OR LOG PLOTTING GRIDS

CALL: CALL LABELX(X1,X2)

ARUGMENTS:
X1,X2 MINIMUM AND MAXIMUM AXIS VALUES
RESPECTIVELY

REMARKS:
EACH GRID LINE CURRENTLY DEFINED IN SUBROUTINE
LINK WILL BE LABELED

USER SUBROUTINE LABELY

PURPOSE: TO LABEL AND SET SCALEING ON Y AXIS
OF LINEAR PLOTTING GRIDS

CALL: CALL LABELY(Y1,Y2,S)

ARUGMENTS:
Y1,Y2 MINIMUM AND MAXIMUM VALUES OF
THE Y AXIS RESPECTIVELY
S MINIMUM X COORDINATE OF Y LABELS
TO AID USER IN PLACING Y AXIS
TITLE INFORMATION

REMARKS:
EACH GRID LINE CURRENTLY DEFINED IN
SUBROUTINE LINK WILL BE LABELED

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USER SUBROUTINE LETTER

PURPOSE: TO PRODUCE HARWARE GENERATED CHARACTER OUTPUT

CALL: CALL LETTER(X,Y,NSIZE,NCHA)

ARGUMENTS:
```
        X,Y      STARTING COORDINATES OF CHARACTER OUTPUT
        NSIZE    CHARACTER SIZE SELECTION(1 TO 4)
        NCHA     CHARACTER ARRAY
```

REMARKS:
```
        CHARACTER ARRAY MUST TERMINATE WITH @
```

USER SUBROUTINE LGNDSH

PURPOSE: TO DRAW A LONG DASHED LINE.

CALL: CALL LGNDSH(X,Y)

ARGUMENTS:
```
        X,Y      THE COORDINATES TO WHICH THE LINE IS DRAWN.
```

REMARKS:

USER FUNCTION QPLT

PURPOSE: TO CONVERT VALUES FROM USER
UNITS TO INCHES FOR PLOTTING.

CALL: PP=QPLT(UNITS)
```
     PP=QPLTX(UNITS)
     PP=QPLTY(UNITS)
```

ARGUMENTS:
```
        UNITS   SINGLE VALUE IN USER UNITS
        PP IS THE RETURNED VALUE IN INCHES
```

REMARKS:
```
        USE QPLT TO INITIALIZE FUNCTION
        (NOT NECESSARY IF LABELX AND LABELY
         HAVE BEEN CALL PREVIOUSLY)
        USE QPLTX TO CONVERT X-AXIS DATA
        USE QPLTY TO CONVERT Y-AXIS DATA
```

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```
USER SUBROUTINE MOVE

     PURPOSE: TO MOVE THE PEN/CURSOR WITHOUT DRAWING TO
              TO A GIVEN LOCATION.

     CALL: CALL MOVE(X,Y)

     ARGUMENTS:
            X,Y       THE COORIDINATES TO WHICH THE PEN/CURSOR
                      IS TO BE MOVED.

     REMARKS:
            N/A
```

```
USER SUBROUTINE NDIM

     PURPOSE: TO GET THE NUMBER OF DAYS IN A MONTH

     CALL: CALL NDIM(MO,IYR,N)

     ARGUMENTS:
            MO        MONTH(1 TO 12)
            IYR       YEAR
            N         RETURNED NUMBER OF DAYS IN MO,IYR

     REMARKS:
            N/A
```

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USER SUBROUTINE NDIS

```
PURPOSE: TO CALCULATE THE NUMBER OF DAYS
         BETWEEN TWO DATES (WHERE THE FIRST
         DATE IS THE END OF A PREVIOUS MONTH)

CALL: CALL NDIS(IM,ID,IY,ND,IFL)

ARGUMENTS:
         IM       MONTH(1 TO 12)
         ID       DAY(1 TO 31)
         IY       YEAR
         ND       RETURNED NUMBER OF DAYS
         IFL      FLAG USED TO INDICATE FIRST CALL
                  OR NOT
                  (IFL=0 INDICATES FIRST CALL,
                  SUBROUTINE WILL INITIALIZE)
                  (IFL=1 INDICATES SUBSEQUENT CALLS)

REMARKS:
         (1) DO NOT CALL THIS ROUTINE WITH LITERALS !!!
         (2) ND MUST BE INTEGER*4
         (3) INITIALIZATION IS TO END OF PREVIOUS
             MONTH ON IFL=0 CALL.  ALL CALLS
             SUBSEQUENT AND HAVING IFL=1 RETURNS
             ND RELATIVE TO THAT DATE
             SEE NDISC FOR NUMBER OF DAYS BETWEEN
             TWO DATES WITHOUT RESTRICTION
         (4) USE NDIS TO PLOT ON GRIT, IFL=0 CALL IS
             NOT NECESSARY IN THIS CASE.
```

```
USER SUBROUTINE NDISC

        PURPOSE: TO CALCULATE THE NUMBER OF
                 DAYS BETWEEN TWO DATES

        CALL: CALL NDISC(IM,ID,IY,ND)

        ARGUMENTS:
                IM      MONTH(1 TO 12)
                ID      DAY(1 TO 31)
                IY      YEAR
                ND      RETURNED NUMBER OF DAYS SINCE
                        BEGINNING MONTH, DAY, AND YEAR
                        SPECIFIED BY INITIAL CALL TO
                        SUBROUTINE NDIS.  SEE NDIS FOR
                        EXPLAINATION.

        REMARKS:
                USE SUBROUTINE NDIS TO INITIALIZE BEGIN
                DATE.
                ND MUST BE INTEGER*4.
```

```
USER SUBROUTINE NDIV

        PURPOSE: SAME AS SETUP

        CALL: CALL NDIV(V,N,ND,VMAX,VMIN,XMAX,XMIN)

        ARGUMENTS: SAME AS SETUP

        REMARKS:
                N/A
```

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```
--------------------------------------------------------------------

USER SUBROUTINE NDIV1

        PURPOSE: SAME AS SET UP

        CALL: CALL NDIV1(ND,VMAX,VMIN,XMAX,XMIN)

        ARGUMENTS:
                ND               SAME AS SETUP
                VMAX,VMIN        SAME AS SETUP
                XMAX,XMIN        INPUT MAXIMUM AND MINIMUM
                                 LABELS DESIRED

        REMARKS:
                N/A

--------------------------------------------------------------------

USER SUBROUTINE NEWPEN

        PURPOSE: TO SET/CHANGE PENS ON FLATBED PLOTTER

        CALL: CALL NEWPEN(IPEN)

        ARGUMENTS:
                IPEN     PEN NUMBER SELECTION(1 TO 4)

        REMARKS:
                N/A

--------------------------------------------------------------------

USER SUBROUTINE NMIS

        PURPOSE: TO CALCULATE THE NUMBER OF MONTHS
                 BETWEEN TWO DATES

        CALL: CALL NMIS(IM,IY,NM,IFL)

        ARGUMENTS:
                IM       MONTH(1 TO 12)
                IY       YEAR
                NM       RETURNED NUMBER OF MONTHS
                IFL      A FLAG USED AS FOLLOWS:
                         IFL=0, INITIALIZE BEGIN DATE(IM,IY)
                         IFL=1, CALCULATE NUMBER OF MONTHS
                                SINCE BEGIN DATE TO CURRENT
                                DATE(IM,IY).

        REMARKS:
                NM MUST BE INTEGER*4.

--------------------------------------------------------------------
```

USER SUBROUTINE NOSTOR

PURPOSE: TO STOP STORING PLOTS ON DISK

CALL: CALL NOSTOR

ARGUMENTS:
NONE

REMARKS:
N/A

USER SUBROUTINE NOW

PURPOSE: TO FORCE IMMEDIATE PLOTTING.

CALL: CALL NOW

ARGUMENTS:
NONE

REMARKS:
PLOTTING IS ACTUALLY DONE WHEN THE
PLOT BUFFER IS FULL. THIS ROUTINE
DUMPS THE BUFFER WHEN IT IS CALLED.

USER SUBROUTINE NUMBER

PURPOSE: TO CONVERT AND PLOT A REAL NUMBER

CALL: CALL NUMBER(X,Y,SIZE,REAL,ANGLE,NW,ND)

ARGUMENTS:

X,Y	THE STARTING COORDINATES OF THE NUMERIC STRING
SIZE	THE HEIGHT OF THE NUMBERS
REAL	THE NUMBER TO BE PLOTTED
ANGLE	THE ANGLE AT WHICH THE NUMBER IS TO BE PLOTTED
NW	THE TOTAL NUMBER OF CHARACTERS TO BE PLOTTED
ND	THE NUMBER OF DECIMAL PLOCES TO PLOT

REMARKS:
N/A

USER SUBROUTINE NYIS

PURPOSE: CALCULATES THE NUMBER OF YEARS IN
A SEQUENCE

CALL: CALL NYIS(IY,NY,IFL)

ARGUMENTS:

IY	YEAR
NY	RETURNED NUMBER OF YEARS
IFL	A FLAG USED AS FOLLOWS: IFL=0, INITIALIZE WITH IY AS BEGINNING YEAR. IFL=1, CALCULATE THE NUMBER OF YEARS TO CURRENT YEAR IY.

REMARKS:

NY MUST BE INTEGER*4

USER SUBROUTINE ORIENT

PURPOSE: TO ORIENTATE THE ENTIRE DRAWING.

CALL: CALL ORIENT(THETA)

ARGUMENTS:

THETA THE ANGLE AT WHICH THE DRAWING IS TO BE ORIENTATED.

REMARKS:

THE ANGLE IS MEASURED FROM THE PLUS X
AXIS IN A COUNTERCLOCKWISE DIRECTION.

USER SUBROUTINE ORIGIN

PURPOSE: TO RESET THE CURRENT DISPLAY ORIGIN

CALL: CALL ORIGIN(X,Y)

ARGUMENTS:

X,Y THE COORIDINATES OF THE NEW ORIGIN.

REMARKS:

THE ORIGIN IS ALWAYS GIVEN IN INCHES
RELATIVE TO THE LOWER LEFT HAND CORNER
OF THE PLOTTING SURFACE.

USER SUBROUTINE PLOT

PURPOSE: TO DRAW A LINE OR MOVE THE PEN/CURSOR TO THE GIVEN LOCATION.

CALL: CALL PLOT(X,Y,L)

ARGUMENTS:

X,Y THE COORDINATES TO WHICH THE PEN/CURSOR IS TO BE MOVED.

L THE PEN COMMAND (1=DOWN,2=UP).

REMARKS:

IF THE PEN COMMAND IS NEGATIVE THE ORIGIN IS RESET TO THE LOCATION OF (X,Y).

USER SUBROUTINE PLT

PURPOSE: SAME AS PLTS

CALL: CALL PLT(X,Y,N,IV)

ARUGMENTS:

SAME AS PLTS EXCEPT SKIP ARGUMENT IS OMITTED

REMARKS:

N/A

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USER SUBROUTINE PLTS

PURPOSE: TO PLOT POINTS ON PREDRAWN GRID

CALL: CALL PLTS(X,Y,N,SKIP,IV)

ARUGMENTS:

```
X,Y     SET OF POINTS TO BE PLOTTED
N       NUMBER OF POINTS IN X,Y SET
SKIP    Y VALUES EQUAL TO SKIP WILL NOT BE PLOTTED
IV      PLOT MODE AS FOLLOWS:
        IV=0 PLOT IN LINE MODE WITH NO SYMBOLS
        IV=1 PLOT IN POINT MODE USING SUBROUTINE CIRCLE
        IV=2,3,4 PLOT IN POINT MODE USING SPECIAL SYMBOLS
```

REMARKS:

TO PLOT IN BOTH LINE AND POINT MODE MAKE TWO CALLS

USER SUBROUTINE RECT

PURPOSE: TO DRAW A RECTANGLE

CALL: CALL RECT(X,Y,XL,YL,ANGLE)

ARGUMENTS:

```
X,Y     COORDINATES OF LOWER LEFT CORNER
XL,YL   WIDTH AND HEIGHT OF RECTANGLE
ANGLE   ANGLE AT WHICH RECTANGLE WILL BE ROTATED
```

REMARKS:

N/A

USER SUBROUTINE REDRAW

PURPOSE: TO REDRAW PSEUDO PLOTS STORED ON DISK

CALL: CALL REDRAW

ARGUMENTS:

NONE

REMARKS:

N/A

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USER SUBROUTINE ROTATE

PURPOSE: TO ROTATE CARTESIAN COORDINATES

CALL: CALL ROTATE(XO,YO,X,Y,NUMPTS,ANGLE)

ARGUMENTS:

XO,YO	POINT OF ROTATION
X,Y	THE SET OF POINTS TO BE ROTATED
NUMPTS	THE NUMBER OF POINTS IN X,Y SET
ANGLE	THE ROTATION ANGLE

REMARKS:
N/A

USER SUBROUTINE SCALE

PURPOSE: TO CHANGE THE CURRENT SCALE FACTORS.

CALL: CALL SCALE(X,Y)

ARGUMENTS:
X,Y THE NEW SCALE FACTORS.

REMARKS:
THIS ROUTINE SETS THE SCALE FACTORS SUCH THAT A PLOTTED POINT IS THE COORIDINATE VALUE MULTIPLIED BY THE SCALE FACTORS.

USER SUBROUTINE SCALE1

PURPOSE: TO CHANGE THE CURRENT SCALE FACTORS.

CALL: CALL SCALE1(X,Y)

ARGUMENTS:
X,Y THE NEW SCALE FACTORS.

REMARKS:
THE SCALE FACTORS ARE SET SUCH THAT A PLOTTED POINT IS THE COORIDINATE VALUE DIVIDED BY THE SCALE FACTOR.

USER SUBROUTINE SCALE2

PURPOSE: TO CHANGE THE CURRENT SCALE FACTORS.

CALL: CALL SCALE2

ARGUMENTS:
NONE

REMARKS:
THE SCALE FACTORS ARE SET TO DEVICE ADDRESS UNITS.

USER SUBROUTINE SCALE3

PURPOSE: TO CHANGE THE CURRENT SCALE FACTORS.

CALL: CALL SCALE3

ARGUMENTS:
NONE

REMARKS:
THE SCALE FACTORS ARE SET TO GIVE TRUE SIZE ON THE TEKTRONIX 4631 HARDCOPY UNIT.

USER SUBROUTINE SCALE4

PURPOSE: TO CHANGE THE CURRENT SCALE FACTORS.

CALL: CALL SCALE4

ARGUMENTS:
NONE

REMARKS:
THE SCALE FACTORS ARE SET TO ALLOW THE TOTAL SURFACE OF THE TEKTRONIX 4954 GRAPHICS TABLET TO BE DISPLAYED ON THE SCREEN.

```
USER SUBROUTINE SETGRD

     PURPOSE: TO SET THE GRID TYPE AND STYLE

     CALL: CALL SETGRD(ITYP,MARK)

     ARUGMENTS:
            ITYP     SET GRID TYPE. MAY HAVE FOLLOWING VALUES:
                             'CC'   LINEAR IN X, LINEAR IN Y
                             'CL'   LINEAR IN X, LOG IN Y
                             'LC'   LOG IN X, LINEAR IN Y
                             'LL'   LOG IN X, LOG IN Y
            MARK     TO SET GRID STYLE. MAY HAVE FOLLOWING VALUES:
                             'SOLID' GRID PLOTTED WITH SOLID LINES
                             'TIC'   GRID PLOTTED WITH TIC MARK
                                     ON EDGES ONLY.
                             'PLUS'  GRID PLOTTED AS IN 'TIC' WITH
                                     PLUS MARKS AT INTERSECTIONS
     REMARKS:
            N/A
```

```
USER SUBROUTINE SETUP

     PURPOSE: TO OPTIMIZE AXIS DIVISIONS AND LABEL VALUES

     CALL: CALL SETUP(V,N,ND,VMAX,VMIN,XMAX,XMIN)

     ARGUMENTS:
            V                ARRAY OF DATA TO BE PLOTTED
                             (X OR Y COORDINATE)
            N                NUMBER OF ELEMENTS IN V
            ND               RETURNED NUMBER OF DIVISIONS
            VMAX,VMIN        RETURNED MAX. AND MIN. AXIS VALUES
            XMAX,XMIN        RETURNED MAX. AND MIN. ELEMENTS OF V

     REMARKS:
            SETUP IS NEW ENTRY FOR NDIV(OLD ROUTINE)
```

```
------------------------------------------------------------------

USER SUBROUTINE SHADE

        PURPOSE: THIS ROUTINE IS A GENERAL PURPOSE SHADING ROUTINE

        CALL:  CALL SHADE (X,Y,INUM,ANG,DIS)

        ARGUMENTS:
                X,Y     X AND Y COORDINATE ARRAYS
                        OF POLYGON TO BE SHADED.
                INUM    NUMBER OF POINTS IN X Y ARRAYS.
                ANG     ANGLE OF SHADING
                DIS     DISTANCE BETWEEN PARALLEL SHADE LINES

        REMARKS:
                POLYGON MUST BE DEFINED IN A CLOCKWISE ORDER WITH
                CONSECUTIVE POINTS. ANGLES SHOULD NOT EXCEED 180
                DEGREES.

------------------------------------------------------------------

USER SUBROUTINE SOLID

        PURPOSE: TO SET THE 4014 TERMINAL TO NORMAL SOLID
                 LINE MODE.

        CALL: CALL SOLID

        ARGUMENTS:
                NONE

        REMARKS:
                N/A

------------------------------------------------------------------

USER SUBROUTINE SORT

        PURPOSE: TO SORT X AND Y DATA ARRAYS

        CALL: CALL SORT(X,Y,NUM)

        ARUGMENTS:
                X,Y     ARRAYS TO BE SORTED
                NUM     NUMBER OF POINTS TO SORT

        REMARKS:
                THIS ROUTINE SORTS IN ASSENDING ORDER USING
                SHELL METHOD

------------------------------------------------------------------
```

USER SUBROUTINE STORE

PURPOSE: TO STORE PLOTS ON THE DISK

CALL: CALL STORE(MOUT)

ARGUMENTS:

MOUT	TYPE OF OUTPUT (ACTUAL OR PSEUDO)

REMARKS:

N/A

USER SUBROUTINE SYMBOL

PURPOSE: TO DRAW ALPHANUMERIC AND SPECIAL CENTERED SYMBOLS

CALL: CALL SYMBOL(X,Y,H,IBCD,THETA,N)

ARUGMENTS:

X,Y	THE STARTING COORDINATES OF CHARACTER STRING
H	THE HEIGHT OF THE CHARACTERS IN INCHES
IBCD	THE ARRAY OF ASCII CHARACTERS TO BE DRAWN
THETA	ANGLE AT WHICH THE ASCII STRING WILL BE DRAWN
N	THE NUMBER OF ASCII CHARACTERS TO DRAW

REMARKS:

IF N IS NEGATIVE A SPECIAL CENTERED SYMBOL IS DRAWN IN WHICH CASE IBCD MUST BE A NUMERIC FROM 1 TO 15

USER SUBROUTINE SYMOFF

PURPOSE: TO APPLY AN OFFSET TO THE STARTING LOCATION OF A CHARACTER STRINGFOR SUBROUTINE SYMBOL

CALL: CALL SYMOFF(IX,IY)

ARUGMENTS:

IX,IY	OFFSET IN GRID COUNTS

REMARKS:

THIS ROUTINE IS USED BY SUBROUTINE CENTER. IT CAN BE USED FOR SPECIAL EFFECTS SUCH AS CENTERING NUMBERS AROUND A DECIMAL POINT ETC.

```
USER SUBROUTINE TABLET

        PURPOSE: TO READ THE TEKTRONIX GRAPHIC TABLET

        CALL: CALL TABLET(X,Y)

        ARUGMENTS:
                X,Y     THE COORDINATES OF THE POINT DIGITIZED
        REMARKS:
                ALL RETURNED DATA IS IN INCHES

-------------------------------------------------------------------

USER SUBROUTINE WHERE

        PURPOSE: TO RETURN THE CURRENT PEN/CURSOR LOCATION.

        CALL: CALL WHERE(X,Y)
        ARGUMENTS:
                X,Y       RETURNED CURRENT PEN/CURSOR LOCATION.

        REMARKS:
                THE COORDINATE LOCATION IS RETURNED IN
                USER UNITS.

-------------------------------------------------------------------

USER SUBROUTINE WINDOW

        PURPOSE: TO CHANGE DISPLAY AREA

        CALL: CALL WINDOW(XL,YL,XU,YU)

        ARGUMENTS:
                XL,YL    LOWER BOUND OF WINDOW
                XU,YU    UPPER BOUND OF WINDOW
        REMARKS:
                N/A

-------------------------------------------------------------------
```

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USER SUBROUTINE WTHRU

PURPOSE: TO SET WRITE-THRU MODE ON THE 4014.

CALL: CALL WTHRU

ARGUMENTS:
NONE

REMARKS:
N/A

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```
------------------------------------------------------------------

INTERNAL SUBROUTINE BUG

        PURPOSE: SETS OUTPUT MODE TO OCTAL FOR DEBUGING

        CALL: CALL BUG

        ARUGMENTS:
                NONE
        REMARKS:
                N/A
------------------------------------------------------------------

INTERNAL SUBROUTINE CORD

        PURPOSE: TO FIND THE LENGTH OF AN AXIS LABEL
                 TO AID LABEL ROUTINES TO POSITION
                 LABELS ON PLOTTING GRIDS

        CALL: CALL CORD(Q,N,D)

        ARGUMENTS:
                Q        VALUE OF LABEL
                N        NUMBER OF DECIMAL PLACES FROM
                         SUBROUTINE NDP
                D        RETURNED LENGTH IN CHARACTER COUNTS

        REMARKS:
                N/A

------------------------------------------------------------------

INTERNAL SUBROUTINE DARK

        PURPOSE: TO MOVE THE TEKTRONIX BEAM WITHOUT
                 DRAWING.

        CALL: CALL DARK(NX,NY)

        ARGUMENTS:
                NX,NY   COORDINATES TO WHICH THE BEAM IS MOVED.

        REMARKS:
                 TEKTRONIX 4014 PLOT ROUTINE.
                NX,NY ARE CALCULATED IN SUBROUTINE EDGE

------------------------------------------------------------------
```

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INTERNAL SUBROUTINE DLAB

PURPOSE: TO PROVIDE DAY OF MONTH LABELS TO GRIT (CALENDAR TIME NOTATION GRID)

CALL: CALL DLAB(XP,ID,S,IX,NOL)

ARGUMENTS:

XP	LABEL POSITION CENTER IN INCHES
ID	DAY OF MONTH(1 TO 31)
S	X AXIS SCALE
IX	OPTION FROM SUBROUTINE SETNX
NOL	FLAG FOR MLAB INDICATING WHETHER LABELS WERE APPLIED (NOL=0, NO LABELS APPLIED) (NOL=1, LABELS WERE APPLIED)

REMARKS:
N/A

INTERNAL SUBROUTINE EDGE

PURPOSE: TO CLIP PLOTS AT PLOTTING WINDOW EDGE

CALL: CALL EDGE(XX,YY,L)

ARGUMENTS:

XX,YY	COORDINATES OF CURRENT PLOT POSITION
L	MOVE OR DRAW INDICATOR
L=1	DRAW
L=2	MOVE

REMARKS:
N/A

INTERNAL SUBROUTINE ENDFIL

PURPOSE: TO WRITE AN EOF MARK ON THE PDP 11/70

CALL: ENDFIL(LUN)

ARGUMENTS:

LUN	LOGICAL UNIT NUMBER

REMARKS:

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INTERNAL SUBROUTINE GET

PURPOSE: TO GET A SET OF CHARACTERS FROM TERMINAL

CALL: CALL GET(NUM,IBUF)

ARGUMENTS:

NUM	NUMBER OF CHARACTERS TO GET
IBUF	RETURNED ARRAY OF CHARACTERS

REMARKS:
N/A

INTERNAL SUBROUTINE LIGHT

PURPOSE: TO MOVE THE TEKTRONIX BEAM AND
DRAW THE LINE.

CALL: CALL LIGHT(NX,NY)

ARGUMENTS:
NX,NY COORDINATES TO WHICH THE BEAM IS MOVED.

REMARKS:
TEKTRONIX 4014 PLOT ROUTINE.
NX,NY ARE CALCULATED IN SUBROUTINE EDGE.

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INTERNAL SUBROUTINE LINK

PURPOSE: TO PROVIDE LINKAGE BETWEEN OTHER
PLOTTING ROUTINES

CALL: CALL LINK(X,Y,N1,N2,K)

ARUGMENTS:

X,Y	VARIES: SEE K			
N1,N2	VARIES: SEE K			
K	LINKAGE CODE USED AS FOLLOWS			
K=1	SAVE LENGTHS OF ABSCISSA AND ORDINATE AXIES AND NUMBER OF DIVISIONS FOR EACH			
K=2	RETURN PARAMETERS SAVED FOR K=1			
K=3	SAVE MINIMUM AND MAXIMUM VALUES OF ABSCISSA			
K=4	SAVE MINIMUM AND MAXIMUM VALUES OF ORDINATE			
K=5	RETURN ABSCISSA VALUES			
K=6	RETURN ORDINATE VALUES			
K=7	STORE GRID TYPE AND GRID MARKING			
	N1	GRID TYPE	N2	GRID MARKING
	1	CART-CART	1	SOLID LINES
	2	LOG-CART	2	TIC MARKED ON INTERSECTIONS
	3	CART-LOG	3	PLUS AT INTERSECTIONS
	4	LOG-LOG	-	
K=8	RETURN GRID TYPE AND GRID MARKINGS			

REMARKS:
N1 AND N2 ARE USED FOR K=1,2,7,8 ONLY
LINK MAY BE USED BY THE USER TO
ACHIEVE SPECIAL EFFECTS(SEE DOCUMENTATION)

INTERNAL SUBROUTINE MLAB

PURPOSE: TO PROVIDE MONTH LABELS FOR GRIT
(CALENDAR TIME NOTATION GRID)

CALL: CALL MLAB(XP,S,IM,IDT,IDL)

ARGUMENTS:

XP	LABEL POSITION IN INCHES
S	X AXIS SCALE
IM	POINTER TO MONTH NAME(1 TO 12)
IDT	NUMBER OF DAYS SINCE LAST MONTH LABEL
IDL	FLAG FROM SUBROUTINE DLAB INDICATING WHETHER DAY LABELS WERE APPLIED

REMARKS:
N/A

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INTERNAL SUBROUTINE NDP

PURPOSE: TO OPTIMIZE THE NUMBER OF DECIMAL PLACES CONTAINED IN AXIS LABELS

CALL: CALL NDP(V1,V2,ND,M,ML)

ARGUMENTS:

V1,V2	MINIMUM AND MAXIMUM AXIS VALUES IN USER UNITS
ND	NUMBER OF DIVISIONS ON THE AXIS
M	RETURNED NUMBER OF DECIMAL PLACES
ML	RETURNED LENGTH OF LARGEST LABEL IN CHARACTER COUNTS

REMARKS:
N/A

INTERNAL SUBROUTINE NOBUG

PURPOSE: TO RESET DEBUG MODE

CALL: CALL NOBUG

ARUGMENTS:
NONE

REMARKS:
N/A

INTERNAL SUBROUTINE OUTPUT

PURPOSE: TO WRITE THE PLOT BUFFER IF REQUIRED.

CALL: CALL OUTPUT(CHA,NSTORE)

ARGUMENTS:

CHA	A CHARACTER TO PUT IN THE BUFFER.
NSTORE	RETURNED INPUT CHARACTER. (USED TO SAVE TERMINAL MODE)

REMARKS:
THE BUFFER WILL BE WRITEN TO THE OUTPUT SELECTED BY SUBROUTINE BEGIN IF IT IS FULL.

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INTERNAL SUBROUTINE PLOTCL

PURPOSE: CALCOMP 925 PLOT ROUTINE

CALL: CALL PLOTCL(X,Y,L)

ARGUMENTS:

X,Y	COORDINATES TO WHICH THE PEN IS TO BE MOVED
L	PEN COMMAND

REMARKS:
N/A

INTERNAL SUBROUTINE PLOTGB

PURPOSE: TO PLOT GERBER 4300 OUTPUT.

CALL: CALL PLOTGB(X,Y,N)

ARGUMENTS:

X,Y	THE PLOT COORDINATES IN TABLE INCHES.
N	THE PEN COMMAND (1=DOWN,2=UP)

REMARKS:
N/A

INTERNAL SUBROUTINE PUT

PURPOSE: TO PUT ONE CHARACTER IN THE PLOT BUFFER.

CALL: CALL PUT(CHA)

ARGUMENTS:

REMARKS:
N/A

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INTERNAL SUBROUTINE PUTBYT

PURPOSE: TO PUT AN INTEGER WORD OUT AS TWO BYTES

CALL: CALL PUTBYT(N)

ARGUMENTS:

N	THE WORD TO BE PLACED IN THE BUFFER

REMARKS:N/A

INTERNAL SUBROUTINE PUTESC

PURPOSE: TO PLACE AN ESCAPE CHARACTER AND ONE CHARACTER IN THE PLOT BUFFER.

CALL: CALL PUTESC(CHA,NSTORE)

ARGUMENTS:

CHA	THE CHARACTER TO BE PUT IN THE BUFFER.
NSTORE	RETURNED INPUT CHARACTER

REMARKS:

N/A

INTERNAL SUBROUTINE PUTG

PURPOSE: TO PUT GERBER PLOT COMMANDS IN THE PLOT BUFFER.

CALL: CALL PUTG(CHA,NUM,N)

ARGUMENTS:

CHA	THE GERBER COMMAND CODE (1 CHARACTER)
NUM	THE NUMERIC DATA ASSOCIATED WITH THE CODE
N	THE NUMBER OF NUMERIC CHARACTERS REQUIRED BY THE CODE.

REMARKS:

TO PLACE A SINGLE CHARACTER IN THE BUFFER USE SUBROUTINE PUT.

INTERNAL SUBROUTINE QUEUE

PURPOSE: TO PLACE A QUEUED OUTPUT CALL ON THE PDP 11/70

CALL: CALL QUEUE(IFUNCT,LUN,IPRM,STAT)

ARGUMENTS:

IFUNCT	I/O FUNCTION CODE
LUN	LOGICAL UNIT NUMBER
IPRM	I/O PARAMETERS
STAT	DIRECTIVE STATUS

REMARKS:
N/A

INTERNAL SUBROUTINE REWIND
INTERNAL SUBROUTINE REWIND

PURPOSE: TO REWIND THE TAPE ON THE PDP 11/70

CALL: CALL REWIND(LUN)

ARGUMENTS:
LUN LOGICAL UNIT NUMBER

REMARKS:
N/A

INTERNAL SUBROUTINE SETNX

PURPOSE: TO SET THE DISPLAY OPTION FOR SUBROUTINE GRIT(CALENDAR TIME NOTATION GRID)

CALL: CALL SETNX(S,IX)

ARGUMENTS:

S	THE X-AXIS SCALE CALCULATED IN GRIT
IX	RETURNED OPTION(1 TO 6)

REMARKS:
N/A

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INTERNAL SUBROUTINE TAPE

PURPOSE: TO SET TAPE CHARACTERISTS ON THE PDP 11/70.

CALL: CALL TAPE(LUN,DENSTY,PARITY)

ARGUMENTS:

LUN	LOGICAL UNIT NUMBER
DENSTY	TAPE DENSITY
PARITY	TAPE PARITY (O=ODD,E=EVEN)
TRACK	NUMBER OF TRACKS (7 OR 9)

REMARKS:

N/A

INTERNAL SUBROUTINE WTAPE

PURPOSE: TO WRITE BCD TAPE OUTPUT ON THE PDP 11/70

CALL: CALL WTAPE(LUN,ERROR,DATA,LENGHT)

ARGUMENTS:

LUN	LOGICAL UNIT NUMBER
ERROR	ERROR RETURN
DATA	DATA TO BE WRITTEN (BYTE)
LENGHT	RECORD LENGHT

REMARKS:

N/A

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INTERNAL SUBROUTINE YLAB

PURPOSE: TO PROVIDE YEAR LABELS TO GRIT
(CALENDAR TIME NOTATION GRID)

CALL: CALL YLAB(XPY1,XPY2,IYR)

ARGUMENTS:

XPY1	POSITION ON GRID WHERE YEAR STARTS IN INCHES
XPY2	POSITION ON GRID WHERE YEAR ENDS IN INCHES
IYR	EITHER A TWO OR FOUR DIGIT NUMBER INDICATING THE YEAR

REMARKS:

IF THE YEAR VALUE IS LESS THAN
1000 ALL CALENDAR TIME ROUTINES
ASSUME THE LAST TWO DIGITS OF THE
YEAR ARE BEING SPECIFIED

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GRAPHICS COMPATIBILITY SYSTEM (GCS)

BY

JAMES M. JONES II
WES ADP CENTER

ABSTRACT

The Graphics Compatibility System (GCS) package is a set of ANSI FORTRAN-IV-callable subroutines unified through a named COMMON area called the Graphic Status Area. The system attributes and control options are provided through this area. The software provides for the display of two- and three-dimensional data.

GCS supports a variety of computer graphics terminals and is available on several types of computers.

The software interface is provided in several basic levels:

1. Simple graphics input/output
2. Window-viewport management with secondary axis control
3. Graphing and analysis output
4. Buffer management for dynamic refresh systems

The GCS sequences are short and consistent. The basic modes of operation are controlled through two routines that set the modes and values for the central management interface, which is the shared common area.

An excerpt from the GCS Programmer's Reference Manual:

> GCS is not just another collection of unrelated graphics subroutines -- it is a unified system which provides the user with the flexibility to perform his tasks at any level of involvement that he desires. Because of this unique man/software relationship, GCS can also be thought of as "user compatible," and it is in this last facet of compatibility that GCS unveils its true potential. Individuals who would normally dismiss graphics for their particular applications are now provided with an alternative. High-level, composite routines are provided to perform relatively complex but frequently required tasks such as the preparation of complete graphs and histograms. Flexibility and adaptability to the needs of the more sophisticated user are achieved by allowing such a user to control the various GCS options which are present to standard default conditions for the unsophisticated programmer. Users of all disciplines may feel equally comfortable with GCS, since they are required to interact only at their particular level of graphics involvement.

Alphabetical Listing of GCS Subroutines

UAIN Accepts one character from the terminal

CALL UAIN (ICHAR)

UALPHA Insures that terminal is in alphanumeric mode

CALL UALPHA

UAOUT Outputs a character at current pen position subject to margining

CALL UAOUT (ICHAR)

UAPEND Inserts the GCS terminator character at the end of a character string

CALL UAPEND (COUNT,STRIN,STROUT)

UARC Draws an arc from current pen position

CALL UARC (X,Y,ANGLE)

U3AREA Sets the 3D device display area associated with the user window

CALL U3AREA (DLEFT,DRIGHT,DBOTTOM,DTOP,DFRONT,DBACK)

UASPCT Forces the display surface dimensions to satisfy the specified aspect ratio

CALL UASPCT (RATIO)

UAVERG Fits a moving average curve to time series data

CALL UAVERG (ARRAY,POINTS,FCST,PERIOD)

UAXIS Draws 2D X,Y axes with appropriate numeric and alphanumeric labeling

CALL UAXIS (XMIN,XMAX,YMIN,YMAX)

U3AXIS Draws general 2D & 3D axes with appropriate numeric and alphanumeric labeling

CALL U3AXIS (XMIN,XMAX,YMIN,YMAX,ZMIN,ZMAX)

UBAR Draws a bar chart with appropriate numeric and alphanumeric labels

CALL UBAR (ARRAY,PTS,LABELS,SIZE)

UBELL Sounds the audible alarm at the terminal

CALL UBELL

UCALL Invokes a graphic data structure in 2-D

CALL UCALL (X,Y,SX,SY,ANGLE,NAME)

U3CALL Invokes a graphic data structure in 3-D

CALL U3CALL (X,Y,Z,SX,SY,SZ,RX,RY,RZ,NAME)

UCHART Produces a grouped bar chart for multi-valued data

CALL UCHART (ARRAY,GROUPS,BARS,LABELS,YMAXL)

UCLOSE Closes the current open frame/segment

CALL UCLOSE (SEGNAM)

UCOLOR This routine defines entries in a program modifiable table of colors

CALL UCOLOR (CINDEX,CCOMP,CNAME,CVALUE)

UCOSYS Creates a 2D user coordinate system

CALL UCOSYS (X,Y,SX,SY,ANGLE)

UCOUNT Returns the number of characters in a U3PRNT output field

CALL UCOUNT (DATA,COUNT)

UCRCLE Draws a circle whose center location and radius are specified.

CALL UCRCLE (X,Y,RADIUS)

U3CSYS Creates a 3D user coordinate system

CALL U3CSYS (X,Y,Z,SX,SY,SZ,RX,RY,RZ,NAME)

UDAREA Sets the 2D device display area associated with user window

CALL UDAREA (XMIN,XMAX,YMIN,YMAX)

UDELAL This routine deletes all currently defined segments (or frames)

CALL UDELAL

UDELET Deletes a currently-defined frame/segment

CALL UDELET (SEGNAM)

UDIMEN Adjusts the physical boundaries of the display surface

CALL UDIMEN (XSIZE,YSIZE)

UDOIT Performs various page layout functions

CALL UDOIT (ACTION)

UDRAW Draws a solid line to the 2D coordinates specified

CALL UDRAW(X,Y)

U3DRAW Draws a solid line to the 3D coordinates specified

CALL U3DRAW (X,Y,Z)

UDRIN Performs the input requested graphic operation and returns request

CALL UDRIN (X,Y,ICHAR)

UEND Terminates graphic operations and positions pen in home position.

CALL UEND

UERASE Erases the screen or requests a clean plotting surface

CALL UERASE

UERROR Returns listing of source records with GCS error commentary

CALL UERROR (ERLAST,TOTAL)

UFLUSH Insures that visual display reflects all net program graphical output

CALL UFLUSH

UFORMT This routine configures the display surface for generation of the requested standard format

CALL UFORMT (FORMAT)

UFRAME Defines the start of a named set of graphical commands

CALL UFRAME (NAME)

UFREND Defines the end of a named set of graphical commands

CALL UFREND (NAME)

UGRIN Gets 2-D coordinates and a character from terminal and returns them

CALL UGRIN (X,Y,ICHAR)

U3GRIN Gets 3-D coordinates and a character from terminal and returns them

CALL U3GRIN (X,Y,Z,ICHAR)

UHDCPY This routine cause a hardcopy to be generated if the device has an on-line immediate hard copy capability.

CALL UHDCPY

UHISTO Draws a histogram with appropriate numeric and alphanumeric labels

CALL UHISTO (ARRAY,PTS,BARS)

UHOME Moves beam to home position

CALL UHOME

U31MAG Applies general 3-D image transformation to "retained" segment (or frames)

CALL U31MAG (X,Y,Z,SX,SY,SZ,RX,RY,RZ,SEGNAM)

UIMAGE Applies general 2-D image transformations to "retained" segments (or frames)

CALL UIMAGE (X,Y,SX,SY,R,SEGNAM)

UINPUT Inputs alphanumeric information from the current position

CALL UINPUT (DATA,COUNT,FLAG,OPTION)

UINVOK Invokes a GCS structure at the current position

CALL UINVOK (NAME)

ULINE Connects an array of 2-D points with current line option

CALL ULINE (X,Y,PTS)

U3LINE Connects an array of 3-D points with current line option

CALL U3LINE (X,Y,Z,PTS)

ULINFT Calculates best linear fit to points provided

CALL ULINFT (X,Y,XN,S,YI)

ULOOK Shifts window to correspond with specified area of screen

CALL ULOOK (XMIN,XMAX,YMIN,YMAX)

ULSTSQ Calculates best polynomial fit to points provided

CALL ULSTSQ (X,Y,XN,COEFF)

UMARGN Sets the left and right, top and bottom alphanumeric window boundaries

CALL UMARGN (XLEFT,XRIGHT,YBOTTOM,YTOP)

UMENU Menu board generating routine

CALL UMENU (POINTS,LABELS,CHOICE)

UMODFY Modifies setting of segment attributes

CALL UMODFY (SEGNAM,NAMAT,ATVALU)

UMOVE Moves the pen to 2-D position specified by input arguments

CALL UMOVE (X,Y)

U3MOVE Moves the pen to 3-D position specified by input arguments

CALL U3MOVE (X,Y)

UNSAVE Restores all variables of the graphic status area

CALL UNSAVE (ARRAY)

UNSHOW	Causes the named frame of graphical information to be made invisible CALL UNSHOW (NAME)
UNSVPN	Restores all pen related variables in the graphics status area. CALL UNSVPN (ARRAY)
UNSVTR	Restores coordinate system related variables in the graphics status area CALL UNSVTR (ARRAY)
UOPEN	Opens a frame/segment CALL UOPEN (SEGNAM)
UORIGN	Creates a user coordinate system at the current beam/pen position CALL UORIGN
UOUTLN	Draws a box around the user's display area CALL UOUTLN
UPAUSE	Pauses for user response CALL UPAUSE
UPEN	Draws a line from current pen position to given 2-D coordinates CALL UPEN (X,Y)
U3PEN	Draws a line from current pen position to given 3-D coordinates CALL U3PEN (X,Y,Z)
UPEN1	Sets one "USET" option for this call only before executing 2-D pen movement CALL UPEN1 (X,Y,OPTION)
U3PEN1	Sets one "USET" option for this call only before executing 3-D pen movement CALL U3PEN1 (X,Y,Z,OPTION)
UPIE	Draws a pie chart with appropriate numeric and alphanumeric labels CALL UPIE (ARRAY,PTS,LABELS,SIZE)
U3PLAC	Applies 3-D translation image transformation to "retained" segments (or frames) CALL U3PLAC (X,Y,Z,SEGNAM)

UPLACE Applies 2-D translation image transformation to "retained" segments (or frames)

CALL UPLACE (X,Y,SEGNAM)

UPLOT General purpose multi-curve 2-D plotting routine

CALL UPLOT (X,Y,CURVES,PARRAY,OPTION)

U3PLOT General purpose multi-curve 3-D plotting routine

CALL U3PLOT (X,Y,Z,CURVES,PARRAY,OPTION)

UPLOT1 Plots a single 2-D curve

CALL UPLOT1 (X,Y,PTS)

UPLYGN Draws a regular polygon

CALL UPLYGN (X,Y,PTSIN,RADIUS)

UPOINT Defines a point which defines a plane for line terminators and tics

CALL UPOINT (X,Y,Z)

UPOST Insures that only defined, visible segments are displayed

CALL UPOST

UPRINT Prints information in hardware or software characters at 2-D position

CALL UPRINT (X,Y,INPUT)

U3PRNT Prints information in hardware or software characters at 3-D position

CALL U3PRNT (X,Y,Z,INPUT)

UPRNT1 Allows alphanumeric output at current position with specified option

CALL UPRNT1 (DATA,OPTION)

UPSET Changes setting in the GSA which requires a parameter value to be set

CALL UPSET (OPTION,VALUE)

UQUERY Obtains current GSA setting

CALL UQUERY (QRYID,VALUE)

UREAD Allows alphanumeric input from the graphic terminal

CALL UREAD (X,Y,DATA,COUNT,FLAG)

URECT Draws a rectangle

CALL URECT (X,Y)

URESET Restores GSA settings to initial values

CALL URESET

U3ROTA	Creates a user coordinate system at current position rotated in 3-D CALL U3ROTA (RX,RY,RZ)
UROTAT	Creates a user coordinate system at current position rotated in 2-D CALL UROTAT (R)
USAVE	Saves all the variables of the graphics status area CALL USAVE (ARRAY)
USAXIS	Draws a single axis with range as specified CALL USAXIS (AXIS,XSTART,YSTART,ZSTART,DIST)
U3SCAL	Creates a user coordinate system at current position with 2-D scaling CALL USCALE (SX,SY)
USCATR	Draws a scatter diagram CALL USCATR (X,Y,PTS)
USET	Sets a graphics status area variable to a given value CALL USET (OPTION)
USHOW	Causes the named frame of graphical information to be made visible CALL USHOW (NAME)
USPLIN	Fits a cubic spline curve to points provided CALL USPLIN (X,Y,PTS,RETX,RETY,RETPTS)
USTART	Initializes the computer system for graphics and erases the screen CALL USTART
USTRCT	Defines the start of a graphic data structure CALL USTRCT (NAME)
USTUD	Gives current setting of the 2-D user display area and window CALL USTUD (ARRAY)
U3STUD	Gives current setting of the 3-D user display area and window CALL U3STUD (ARRAY)
USVPN	Saves all pen-related variables of the graphics status area CALL USVPN (ARRAY)
USVTR	Saves coordinate system related variables in the graphics status area CALL USVTR (ARRAY)

UTAXIS Draws a time series axis with appropriate alphanumeric and numeric labels

CALL UTAXIS (BEGIN,PERIOD,YMIN,YMAX)

UTERM Defines the end of a graphic data structure

CALL UTERM (NAME)

UTILTY Performs data structure utility functions

CALL UTILTY (OPTION,VALUE)

UTSFIT Fits an exponentially smoothed curve to time series data

CALL UTSFIT (ARRAY,POINTS,FCST,ALPHA)

UVIEW Define the viewing vector

CALL UVIEW (XVIEW,YVIEW,ZVIEW,XSITE,YSITE,ZSITE)

UVWPLN Defines the location of the view (projection) plane

CALL UVWPLN (DISTAN)

UVWPRT Defines the location of the view (projection) plane (obsolete, see UVWPLN)

CALL UVWPRT (DISTAN)

U3WHER Returns the 3-D coordinates of the current pen position in user units

CALL U3WHER (X,Y,Z)

UWHERE Returns the 2-D coordinates of the current pen position in user units

CALL UWHERE (X,Y)

UWINDO Sets the virtual 2-D window boundaries

CALL UWINDO (XMIN,XMAX,YMIN,YMAX)

UWLOOK Shifts UDAREA to correspond to specified window

CALL UWLOOK (XMIN,XMAX,YMIN,YMAX)

U3WNDO Sets the virtual 3-D window boundaries

CALL U3WNDO (XMIN,XMAX,YMIN,YMAX,ZMIN,ZMAX)

U3WRIT Prints information at 3-D position, then restores pen to location on input

CALL U3WRIT (X,Y,Z,DATA)

UWRITE Prints information at 2-D position, then restores pen to location on input

CALL UWRITE (X,Y,DATA)

UWRIT1 Allows alphanumeric output at current position with specified one option

CALL UWRIT1 (DATA,OPTION)

UZWNDO Sets the hither/yon window boundaries for z-clipping

CALL UZWNDO (ZMIN,ZMAX)

SUMMARY OF GRAPHICS SOFTWARE

by Dr. N. Radhakrishnan

ABSTRACT

The paper summarizes the graphics software packages discussed in the Software Session. The summary includes the objectives, capabilities, advantages, and disadvantages of each package. Comparisons between the packages based on an example problem are made. The advantages of having a "standard or preferred" graphics software package for Corps-wide use is also addressed.

SUMMARY OF GRAPHICS SOFTWARE

by Dr. N. Radhakrishnan*

Graphics Software Used

The U. S. Army Corps of Engineers primarily uses the following six graphics software packages:

1. CALCOMP (California Computer Product Co.)
2. DISSPLA (Integrated Software System Corps.)
3. PLOT 10 (Tektronix Inc.)
4. GPLOT (Jacksonville District)
5. BIGS (Boeing Interactive Graphics System)
6. GCS (Graphics Compatibility System, WES)

In addition there are two other graphics software systems that are widely used in the international community:

1. GPGS (General Purpose Graphics System, Norway)
2. GINO-F (CAD Center, England)

Capabilities, Advantages, and Disadvantages

Each graphics software system has its own capabilities, advantages, and disadvantages. These are tabulated in Tables 1-6, for the six systems used by the Corps.

Common Features of Software

In spite of the multitude of software systems that exist, practically all of them have some basic common capabilities and features. Some of these features include:

1. FORTRAN subroutines
2. Simple line drawing
3. Different line types
4. General purpose axis generation
5. Automatic clipping
6. Graphics input
7. Arc generation
8. Hardware/software characters

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* Special Technical Assistant, Automatic Data Processing Center, Waterways Experiment Station

CALCOMP

California Computer Product Co.

Objective

CALCOMP software was developed for a FORTRAN-oriented programmer to write graphics computer programs for a CALCOMP offline or online pen plotting system.

Capabilities

CALCOMP is a widely used and much simulated software package exhibiting a large degree of computer independence.

Advantages of CALCOMP

- FORTRAN subroutines
- Computer independent
- Widely used in Corps
- Source code available
- Wide user base (outside Corps)

Disadvantages of CALCOMP

- Proprietary
- Device dependent
- Passive graphics only
- No device/computer implementation guidelines

Table 1

DISSPLA

Integrated Software System Corp.

Objective

DISSPLA was developed to provide users a complete set of graphics routines for extensive user-control of graphical images.

Capabilities

DISSPLA is a system of FORTRAN subroutines which may be interfaced to all graphics devices attached on- or off-line to a host computer. It enables the user to transform data into a wide variety of data displays such as charts, graphs, and maps.

Advantages of DISSPLA

- FORTRAN Subroutines
- Computer/device independent
- Medium user base (outside corps)
- Supports passive/interactive graphics
- Several character sets
- Mapping
- Report quality plots

Disadvantages of DISSPLA

- Proprietary
- No source code available
- No device/computer implementation guidelines
- Psuedo file use only
- Limited support for interactive graphics input
- Software generated characters
- No Corps expertise on internal software
- Only one Tektronix device driver

Table 2

PLOT-10

Tektronix Inc.

Objective

PLOT-10 software was developed to support graphics on Tektronix terminals being used in many computer environments.

Capabilities

PLOT-10 software is a comprehensive set of FORTRAN subroutines that is largely computer independent but very device dependent. Interactive graphics is supported directly and passive graphics is supported only by a "preview" package.

Advantages of PLOT-10

- FORTRAN subroutines
- Computer compatible
- Source code available
- Large user base (outside Corps)
- Most Corps interactive graphics terminals are Tektronix
- Previewing capability for existing CALCOMP programs

Disadvantages of PLOT-10

- Proprietary
- Device dependent
- Several versions
- No device/computer implementation guidelines
- No Corps expertise on internal software

Table 3

GPLOT

Jacksonville District

Objective

GPLOT was developed by Jacksonville District to provide general purpose plotting routines on the PDP-11 minicomputer.

Capabilities

GPLOT supports both passive/interactive graphics on a variety of output devices. It supports the basic CALCOMP subroutine calls as entry points in the software.

Advantages

- Nonproprietary
- FORTRAN subroutines
- Computer/device independent
- Source code available
- Supports passive/interactive graphics
- Basis CALCOMP calls supported

Disadvantages

- Small user base (only Corps)
- Limited support
- No Device/computer implementation guidelines

Table 4

BIGS

Boeing Interactive Graphics System

Objective

BIGS software was developed to provide users the opportunity to obtain interactive graphics displays on low-cost graphics terminals with the Kronos Interactive Timesharing (KIT) System.

Capabilities

BIGS is a user-oriented system that provides rapid and easy access to graphic display terminals. It automatically generates standard-type displays, such as grids, axes, curves, menus, charts, and tables.

Advantages of BIGS

- FORTRAN subroutines
- Device independent
- Supported on Corps contract computer
- Optional precompiler for display statements

Disadvantages of BIGS

- Proprietary
- Computer dependent
- Interactive graphics only
- No source code available
- No computer/device implementation guidelines
- No Corps expertise on internal software

Table 5

GCS

Graphics Compatibility System, WES

Objective

GCS was designed to support interactive and passive graphics on a wide variety of computer graphics devices.

Capabilities

GCS is a FORTRAN-based graphics system that supports two- and three-dimensional plotting on a variety of computer graphics terminals. The software is written in a manner aimed at minimizing problems when moving the system to other computers.

Advantages of GCS

- Nonproprietary
- FORTRAN subroutines
- Computer/device independent
- Source code available
- Medium user base (outside Corps)
- Supports passive/interactive graphics
- Device/computer implementation guidelines

Disadvantages of GCS

- Incompatibility of 2-D and 3-D GCS
- Deficiencies in input/interactive area
- Lack of contouring
- Lack of publication quality plots
- Lack of hidden line/surface elimination

Table 6

The ACM SIGGRAPH group in a study (Ref 1), suggested a set of features and capabilities for what key called a CORE system. Most of the above mentioned software have many or all of the features of the CORE system. Thus it is possible to visualize the various systems to be different mainly on the semantics used in the user interface. Figure 1 shows this concept. As an example, to draw a solid line the following commands are required:

Graphics Software	Subroutine Call
CALCOMP	Call PLOT (X,Y,2)
PLOT 10	Call DRAWA (X,Y)
BIGS	Call DRAWA (X,Y) (Interfaces with PLOT 10)
GPLOT	Call PLOT (X,Y,2)
DISSPLA	Call CONNPT (X,Y)
GCS	Call UPEN (X,Y)

To plot axes and connect data points the following commands are required:

CALCOMP	PLOTXY (X,Y,PTS,ICOME)
PLOT 10	NPTS(PTS)+CHECK (X,Y)+DISPLAY (X,Y)
BIGS	GENPLT (ITITLE, NCHARS,X,Y,PTS,JTYPE)
GPLOT	AUTO (X,Y,PTS,NAME,DEVICE)
DISSPLA	LINPLT (X,Y,PTS)
GCS	UPLOTI (S,Y,PTS)

Comparison of Software

A benchmark program was developed to provide a means of comparing the different graphics software systems used by the Corps. The benchmark program plots ten (X,Y) points on an automatically generated axes (See Figure 2). The benchmark was written for GCS, PLOT 10, BIGS, and DISSPLA and executed on Boeing's CDC computer in Seattle, Washington. The tabulated results are:

Software	CP Time (Seconds)	Memory (60 Bit Word)
GCS	.014	18383
GCS (without curve fitting)	.016	16240

Software	CP Time (Seconds)	Memory (60 Bit Word)
PLOT 10	.020	16185
BIGS (alway generate psuedo file)	.038	17697
DISSPLA	.152	20670

The benchmark was also written for GCS, PLOT 10 and GPLOT and executed on the Corps' Harris 120 minicomputer at the Wilmington, South Carolina District Office. The tabulated results are:

Software	CP Time (Seconds)	Memory (24 Bit Word)
GCS	.16	16802
GCS (without curve fitting)	.25	13750
PLOT 10	.25	15606
GPLOT	1.02	12839

These benchmarks indicate that selection of software will be important if execution time and memory are items of concern.

Software Support.

Supporting all the graphics software systems used by the Corps will not be practical due to problems that would arise in maintenance, training, and transportability. It is necessary for the Corps to have software that can support both passive and interactive graphics. It is recognized that CALCOMP software is the "defacto" standard for passive graphics. However, interactive graphics is relatively new and no one software system can claim to be a "defacto" standard. However, adoption of a "standard or a preferred graphics system" that provides both program and programmer portability will eliminate future problems in maintenance and transportability.

Problems with Standards.

It is probably true that no one likes standards, standards are generally acceptable if only a single system exists or the standard system adopted happens to be the one a person currently uses! With a versatile standard one has perhaps to pay for machine and device portability. That is, a machine transportable standard could result in more care and may be less efficient in execution. However, the benefits

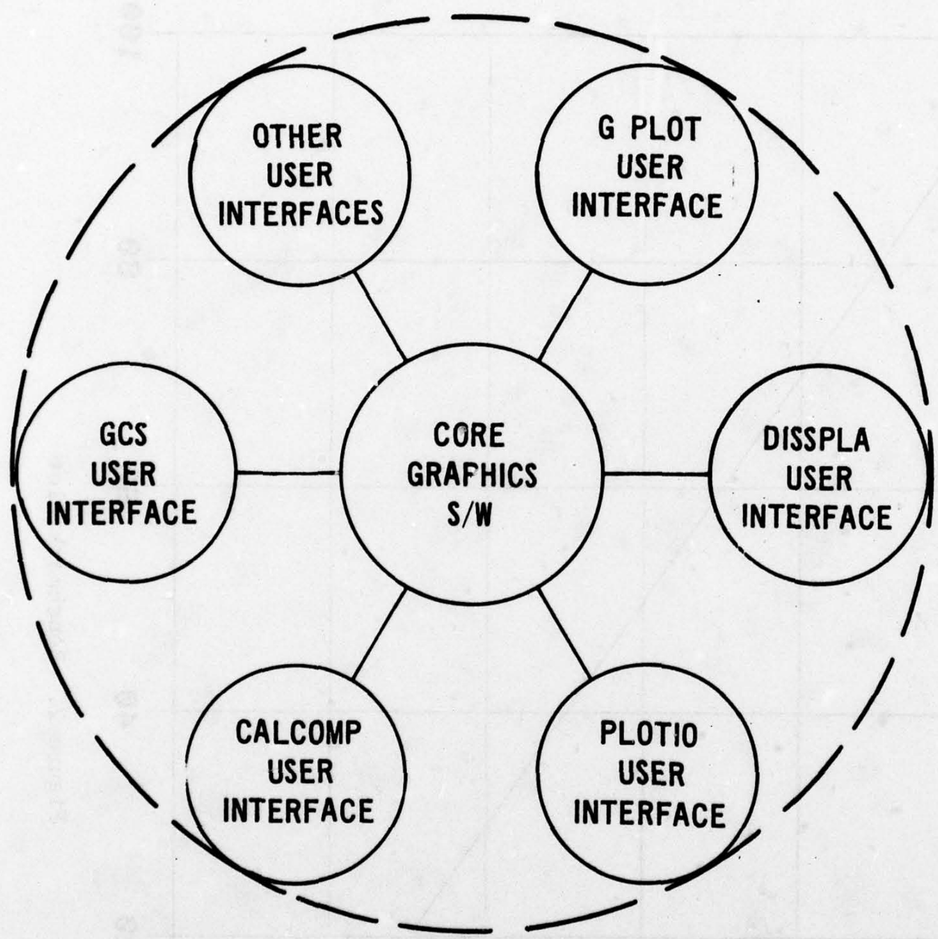

Figure 1. Conceptual Visualization of Graphics Systems

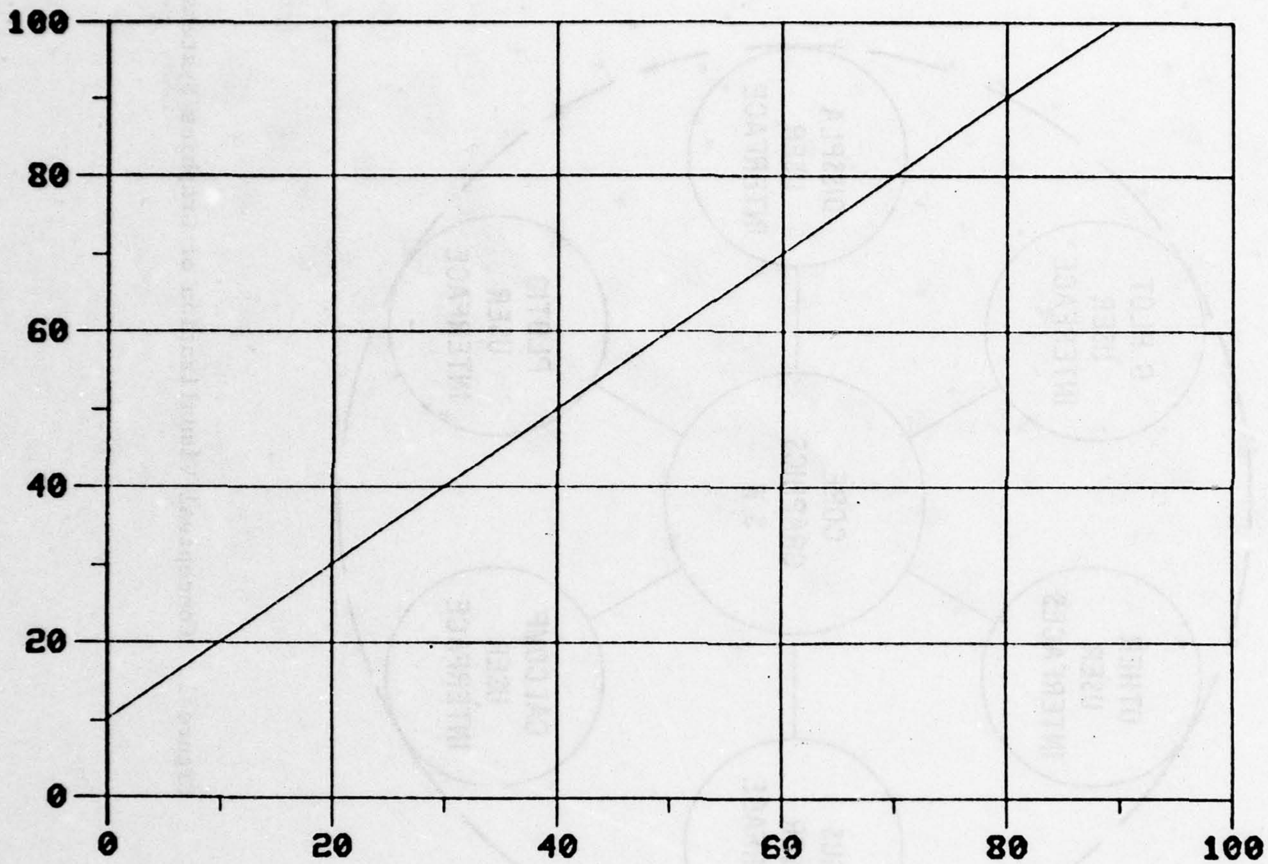

Figure 2. Benchmark Plot

of adopting a standard far out weigh the disadvantages. The point is, you can't have your cake and eat it too!

Advantages of Standards

There are three advantages for adopting a standard system:

1. Program Portability
2. Programmer Portability
3. Avoidance of Duplication.

A standard system will mean savings in manpower and funds. Since the Corps' involvement in interactive graphics is just starting, it is easier now to adopt a standard graphics software system that would permit orderly growth.

What Should a Standard System Have?

A standard graphics system for the Corps should have, in my opinion, most of the following features:

1. CALCOMP calls should be part of it to reduce the learning process.
2. Written in FORTRAN for computer transportability
3. As graphics device independent as possible
4. Modular programming for easy maintenance
5. Well documented
6. Easy to learn by average user.

Summary

The time to adopt a standard is now. If the Corps waits, a prohibitive investment in training and software conversion will be necessary. A standard graphics software system will provide the Corps a tool to best support its present and future graphics needs.

Acknowledgements

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HARDWARE

COMPUTER GRAPHICS HARDWARE IN THE CORPS

by

JAMES W. DAHLEN

Today I would like to present to you an overview of graphics hardware currently installed within the Corps. The discussion relates only to those offices returning questionnaires sent out by WES earlier this spring. Of 59 Corps DPI's, only 36 responded to the questionnaire, so the number of individual graphic devices represented here do not indicate all that are installed in the Corps. However, the types of equipment do represent a good cross-section of those installed.

The equipment can be classified into two categories; namely, those that process passive graphics and those that process interactive graphics. The passive graphics devices are generally those devices which produce plots or displays from tapes or data files previously generated by a computer. CRT's can display passive too. The questionnaires returned indicated 24 different makes and models of plotters, and 65 separate pieces of plotting equipment.

The 18 flatbed plotters reported (Table 1) vary considerably in age and capability. Because of time constraints, I will only touch briefly on some characteristics of some of the newer flatbed plotters.

The Tektronix 4662 is a small pen plotter which attaches to Tektronix terminals. It is not in the class of other installed plotters; however, it is very capable of producing some very useful small plots at the engineer's work station. As shown on Table 2, the plot surface is 15" x 10" and operates a single nylon-tipped pen at 16 IPS, with an accuracy of 0.4% per vector length.

The 748 flatbed is a part of Calcomp's 7000 high performance drafting system and is the latest true flatbed plotter Calcomp has marketed. As shown on Table 3, it has a large plot surface of 48" x 82" and plots with a pressurized four pen ink system at 30 IPS axial velocity and acceleration of 1G. In addition, the plot head can accomodate pressure ballpoint pens and a scribe tool holder. The 748 operates with a step size of .0002 inches.

The Gerber 4343 curvalinear flatbed plotter is the flatbed plotter which is specified on a Corps-wide requirements-type contract. As shown on Table 4, it has a large plot surface of 48" X 88" and plots with liquid ink at approximately 12 IPS and plots with ballpoint or nylon-tipped pens at up to 21.2 inches per second. The plot head also accomodates a scribe tool holder.

The 47 installed drum plotters (Table 5) are predominantly Calcomp and vary considerably in age and capability. Note that there were seven AJ832 keyboard terminals reported as plotting devices which are classified as drum plotters because of the platten movement. The terminals do have the capability to output plots, and Anderson Jacobson does supply the software to drive them. The end product is very suitable for some applications, but the plot generation ranges from "slow" to "slower", depending upon the data rate being used.

The predominent drum plotting equipment installed in the Corps is the Calcomp 926, 1036 and 1039 plotters. The 1039 plotter is one of a new series of plotters announced by Calcomp and is the plotter specified in the Corps of Engineers requirements-type contract for drum plotters. A comparison of the capabilities of the three plotters is shown on Table 6. The 936 and 1036 are essentially the same except for the axial speed and options which were available. The 1039 plotter was introduced to replace the 936 plotter

and has improved capabilities such as 25% faster, one inch wider plotting width and capability to use nylon tipped pens.

On the interactive graphics side, 11 different models comprising 111 devices were reported (Table 7). It can be readily seen that Tektronix seems to have a corner on the Corps' market. The installed Tektronix graphic terminals all use storage tube displays except the 4081 interactive graphics terminals which use both storage and refresh graphics technology. The display tubes on the installed equipment range in size from 7.5" X 5.6" on 4006 and 4010, to 15" X 11" on the 4014's and 4081's. In addition to those terminals reported, at least 15 more 4014's and one 4051 are being purchased this fiscal year ending 30 September 1978.

The 4014 is by far the most popular graphic terminal in the Corps if numbers mean anything. The price performance ratio and ease of use make the equipment popular, especially in the New Orleans District which boasts 18 of them currently installed. As shown on Table 8, the 4014 has a large screen size of 15" X 11" and can have as many as 4096 X 3120 addressable points for display. It has a full 96 character ASCII keyboard and can display four different program selectable alphanumeric character sizes with 74, 81, 121 and 133 characters per line. Depending upon the size selected, it can also display five vector formats including straight, dotted and dashed lines. The 4014 has many peripheral options available including hard copy unit, digital plotters, floppy disk, cartridge tape recorder, joy stick for positioning cross hairs, and graphic tablets in two sizes for digitizing. A new option 40 is now available which provides some intelligence to the terminal and appears to be a considerable enhancement to the product.

The 4051, eight of which were reported, is called "The basic graphic computing system." It has programmable capability in the basic language and can be operated on-line to a host computer, or off-line in a stand alone mode. It can utilize the same peripherals as the 4014. The one disadvantage as I see it, is the small screen size of 8" x 6".

The 4081, two of which were reported, is called an "Interactive Graphics Terminal." The 4081 has two basic modes of operation: 1) stand alone, and 2) intelligent terminal. In the stand alone mode it has assembler language and Fortran IV compilers. As an intelligent terminal, the 4081 program can communicate with a Fortran program in a host computer. The 4081 can do local scaling, rotation and translation of pictures or picture segments. As I previously stated, the 4081 operates in both storage and refresh mode. The 4081 also has a 4014 emulation. The price range is considerably higher than other Tektronix devices.

After a cursory look at the graphic equipment currently installed in various places throughout the Corps, it appears that we have quite a mixed bag of capability and software needed for operation. This is true in the area of passive graphics plotting equipment. As the equipment ages, our problems begin to grow. It was quite a shock to some to receive letters from Calcomp this year telling them that monthly maintenance would no longer be available for their installed equipment after 1 April 1979. I queried my Calcomp representative about the action and was told that they sent letters out for all equipment which had not been manufactured for seven years or longer. This was something that they had never done before. However, it can probably be expected to continue into the future. Calcomp is saying they will not

guarantee maintenance beyond seven years from date of order. Incidentally, Tektronix served the same notice on the 4002 graphic terminals installed throughout NPD.

Let's take a look at how this impacts the Corps. This forces certain offices into immediate thoughts of having to replace certain equipment. Of all the Calcomp flatbed plotters installed in the Corps, only the 748 is still in production and Calcomp is rumored to be working on a replacement product. Of the drum plotters currently installed in the Corps, only the 1039 is still in production. The 936 and 1036 drums have not been manufactured since 1 October 1977. Calcomp has announced a line of five new plotters from Model 1037 to Model 1055 to replace previous products.

What can we do for replacements? Money must be budgeted in the Plant Replacement and Improvement Program before procurement can be accomplished. This has taken at least two years in the past, however, an opportunity was given this year to revise DPI acquisition projections for next year. After the money is budgeted, the choices are to use the requirements type contracts or justify an alternate procurement if that contract equipment will not meet your requirements. As stated previously, the flatbed plotter contract equipment is a Gerber Model 4343 curvalinear flatbed, and the drum plotter contract equipment is a Calcomp 1039 with a 921 controller.

Prior to making a determination, a DPI should consult with those operating the particular equipment to obtain their assessment of its capabilities. Many pitfalls are not readily apparent and I would like to mention some of them relating to the contract equipment.

The Gerber equipment appears to be excellent and has the ability to produce very accurate plots. The controller has 48K byte Hewlett Packard 21MX minicomputer internally to drive it. This has high potential but Gerber has no interest in improving the controller software. The software calls are not compatible with any other software, thus requiring rewriting all host software or using some compatibility routine as most of us have done. The plotter will not process roll paper. The equipment will not handle material thicker than 10 mills. The axial acceleration 0.707g makes our 10 inch per second 1036 drum plotter look very fast if much detail or alphanumeric data is being plotted. It will not move the pen continuously on curvature where small incremental line segments are used.

The Calcomp 1039 requires much less of a decision making process. The primary considerations are whether the 4.5 inches per second is fast enough, and if three rather than four pen holders is enough. The plotter is open, sits on a table and may require an acoustic cover to deaden the noise. The 921 controller driving the 1039 has no programmable capability and thus does not have the ability to scale, rotate or window a plot. If this is desired, the plot must be rerun on the host computer before replotting. This is not a serious drawback since a 921 can be field upgraded to a 925 which does have the capabilities.

New graphics equipment is continually being developed. Calcomp's new top-of-the-line drum plotters offer new capabilities such as four pen plot heads, speeds up to 30 inches per second and acceleration up to 4g. Model 1051 operates at 10 inches per second and has a resolution of .001 inch. The 1055 operates at speeds up to 30 inches per second and has a resolution of 0.0005 inch.

Huntington District is in the process of acquiring a Calcomp 1051 drum plotter. Wilmington is in the process of getting acquisition approval to replace their Calcomp 718. WES is in the process of acquiring a passive graphics device with new technology. The Comtal 200F is an image processing system and displays full-color presentation of digital image date. The image is displayed on the screen from magnetic tape data in much the same manner as an off-line plotter. It takes approximately one minute to make a new display and refreshes it 30 times per second until a new image is desired. The only method of capturing the image is by external photography.

In the next few years we may all be faced with acquiring a new generation of equipment. Hopefully we will not all go in diverging ways and acquire different non-compatible equipment. We *must* find some way of sharing our ideas and studies, and even equipment justifications, in order that we might maximize our future graphics capabilities, while at the same time minimizing resources required to achieve desired end products.

We are always being asked to quantify and put values on everything. In fact, last light I was asked the question "What is computer graphics worth?" I will leave you with an old saying, modified for computer graphics, "One picture is worth one thousand and twenty-four words."

P A S S I V E   G R A P H I C S

FLATBED PLOTTERS

CALCOMP	501	1
	618	1
	638	1
	702	1
	718	1
	748	4
TEKTRONICS	4662	2
GERBER	4343	7

T A B L E   1

AD-A062 478   ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 9/2
GRAPHICS IN THE CORPS. PROCEEDINS OF THE COMPUTER GRAPHICS COLL--ETC(U)
1978   J M JONES, R L HALL, N RADHAKRISHNAN

UNCLASSIFIED   NL

3 OF 5
AD
A062478

T E K T R O N I X   4 6 6 2

PLOT SURFACE	15" X 10"
PLOT RATE	16 IPS
NO. PENS	1
PEN TYPE	NYLON TIPPED
ACCURACY	0.4% VECTOR LENGTH

T A B L E   2

CALCOMP 748

PLOT SURFACE	48 X 82
PLOT RATE (AXIAL) MAX	30 IPS
NO. PENS	4
TYPE PENS	PRESSURIZED WET INK BALLPOINT AND SCRIBE TOOLS
STATIC POSITIONAL ACCURACY	± 0.004 INCHES

TABLE 3

GERBER 4343

PLOT SURFACE	48" X 88"
PLOT RATE (AXIAL) MAX	21.2 IPS
NO. PENS	4
TYPE PENS	LIQUID INK
	BALLPOINT
	NYLON TIPPED
	SCRIBE TOOLS
POSITIONAL ACCURACY	0.005 INCHES

TABLE 4

PASSIVE GRAPHICS

DRUM PLOTTERS

CALCOMP	563	6
	663	2
	763	1
	936	9
	937	1
	1036	6
	1039	4
BENSON/LEHNER	305	1
AUTOTROL	6030	1
IMPACT PLOTTER	AJ832	7
MISC. OTHER		9

TABLE 5

CALCOMP DRUM PLOTTERS

	936	1036	1039
PLOT WIDTH	33"	33"	34"
PLOT RATE (IPS) AXIAL	3.6"	10"	4.5"
NO. PENS	3	3	3
TYPE PENS	LIQUID INK & BALLPOINT (NYLON TIP)		
STEP SIZE	0.002	0.002	0.002

TABLE 6

INTERACTIVE GRAPHICS

TEKTRONIX	4002	4
	4006	1
	4010	5
	4012	5
	4013	1
	4014	82
	4015	1
	4051	8
	4081	2
OTHERS		3

11 MODELS

111 DEVICES

TABLE 7

TEKTRONIX 4014-1

LARGE SCREEN SIZE	15" X 11"
HIGH RESOLUTION	4096 x 3120 POINTS

FULL 96 CHARACTER KEYBOARD

4-PROGRAM SELECTABLE A/N FORMATS (74,81,121 & 133 CPL)

5 VECTOR FORMATS INCL. STRAIGHT, DOTTED & DASHED LINES

PERIPHERALS AVAILABLE

- HARD COPY UNIT
- DIGITAL PLOTTER
- FLOPPY DISK
- CARTRIDGE TAPE RECORDER
- JOY STICK FOR CROSS HAIRS
- GRAPHIC TABLET

OPTION 40 NOW AVAILABLE WHICH
PROVIDES INTELLIGENCE TO TERMINAL

TABLE 8

GRAPHICS EQUIPMENT

	Equipment	# Units	Manufacturer	Model #	Primary Software Used
Huntsville Division	Storage Tube Graphics	1	Tektronix	4014	GCS
Lower Miss Valley Div.	Storage Tube Graphics	1	Tektronix	4014	GCS, PLOT-10, INFONET
Vicksburg Dist.	Storage Tube Graphics	2	Tektronix	4014	GCS
	Intelligent Graphics	1	Tektronix	4081	PLOT-80
St. Louis Dist.	Flatbed Plotter	1	CALCOMP	618	CALCOMP
	Storage Tube Graphics	3	Tektronix	4014	GCS
	Intelligent Graphics	1	Tektronix	4051	TK Software
Memphis Dist.	Flatbed Plotter	2	CALCOMP	748/702	CALCOMP
	Storage Tube Graphics	6	Tektronix	4012/4014	GCS
New Orleans Dist.	Drum Plotter	1	CALCOMP		CALCOMP
	Storage Tube Graphics	18	Tektronix	4014	GCS
Missouri River Division	Storage Tube Graphics	1	Tektronix	4014	GCS, PLOT-10
Kansas City District	Drum Plotter	1	CALCOMP	937	CALCOMP
	Flatbed Plotter	1	Gerber	4300	Gerber
Omaha District	Drum Plotter	1	CALCOMP	1036	CALCOMP
	Storage Tube Graphics	1	Tektronix	4014	CALCOMP
North Atlantic Division	CRT Plotter	2	Hazettin	1000	
New York District	Drum Plotter	1	CALCOMP	1039	CALCOMP
Norfolk District	Drum Plotter	1	CALCOMP	1039	CALCOMP
Philadelphia District	Drum Plotter	1	Autotrol	6030	Software
	Storage Tube Graphics	1	Tektronix	4010	Software
	Flatbed Plotter	1	Autotrol	6030	Software
Baltimore Dist.	Drum Plotter	1	CALCOMP	1039	
	Intelligent Graphics	1	Tektronix	4051	
New England Division	Drum Plotter	2	CALCOMP	925/1036	CALCOMP
North Central Division	Drum Plotter	1	CALCOMP		
Buffalo	Flatbed Plotter	1	CALCOMP	7000	CALCOMP
Rock Island Dist.	Flatbed Plotter	1	Gerber	43	CALCOMP
	Storage Tube Graphics	3	Tektronix	4014	Tektronix

GRAPHICS EQUIPMENT

	Equipment	# Units	Manufacturer	Model #	Primary Software Used
North Central Division					
Detroit District	Drum Plotter	1	CALCOMP	936	CALCOMP
	Flatbed Plotter	1	CALCOMP	501	CALCOMP
	Storage Tube Graphics	1	Tektronix	4014	GCS
	Others	2	AJ832	832	AJ
St. Paul District	Drum Plotter	1	CALCOMP	563	CALCOMP
	Flatbed Plotter	1	Gerber	43	Gerber
	Storage Tube Graphics	1	Tektronix	4014	
North Pacific Division	Storage Tube Graphics	2	Tektronix	4010/4014	
Seattle District	Drum Plotter	1	CALCOMP	925/1036	CALCOMP
	Flatbed Plotter	1	Gerber	4343	Gerber
	Storage Tube Graphics	2	Tektronix	4002/4014	PLOT-10
Portland District	Flatbed Plotter	1	CALCOMP	748	CALCOMP
	Storage Tube Graphics	1	Tektronix	4014	PLOT-10
	Storage Tube Graphics	1	Tektronix	4051	PLOT-10
Walla Walla District	Storage Tube Graphics	1	Tektronix	4014	PLOT-10
Ohio River Division	Drum Plotter	1	CALCOMP	925/936	CALCOMP
	Storage Tube Graphics	[illegible]	Tektronix	4014	CALCOMP/PLOT-10
Louisville District	Drum Plotter	1	CALCOMP	760/663	CALCOMP
	Flatbed Plotter	1	Gerber	4343	Gerber
	Others	5	AJ832	832	AJ
Pittsburgh District	Drum Plotter	1	CALCOMP	915/1036	CALCOMP
Nashsville District	Storage Tube Graphics	6	Tektronix	4014	
	Drum Plotter	1	CALCOMP	936	CALCOMP
Huntington District	Drum Plotter	1	CALCOMP	925/763	CALCOMP
	Flatbed Plotter	1	CALCOMP	925/748	CALCOMP
	Storage Tube Graphics	1	Tektronix	4014	CALCOMP, PLOT-10
	Others	1	DIABLO	1620	DIABLO
	Others	2	ACS	3750	
South Atlantic Division	Storage Tube Graphics	2	Tektronix	4010/4014	PLOT-10, Tektronix

GRAPHICS EQUIPMENT

	Equipment	# Units	Manufacturer	Model #	Primary Software Used
Savannah District	Drum Plotter	1	CALCOMP	1039	CALCOMP
	CRT Plotter	1	Tektronix	4010	PLOT-10
Charleston District	Drum Plotter	1	CALCOMP	936	CALCOMP, GCS
	Storage Tube Graphics	1	Tektronix	4014	PLOT-10, GCS
Jacksonville District	Flatbed Plotter	1	Gerber	4343	GPLOT(In-House)
	Storage Tube Graphics	2	Tektronix	4014	GPLOT(In-House)
Mobile District	Drum Plotter	1	CALCOMP	1036	CALCOMP
	Storage Tube Graphics	2	Tektronix	4014	PLOT-10, GCS
Wilmington District	Flatbed Plotter	1	CALCOMP	718	CALCOMP
	Storage Tube Graphics	1	Tektronix	4014	PLOT-10
South Pacific Division	Drum Plotter	1	CALCOMP	663	CALCOMP
	Flatbed Plotter	1	CALCOMP	638	CALCOMP
Sacramento District	Drum Plotter	1	CALCOMP	936	CALCOMP
	Storage Tube Graphics	2	Tektronix	4014	Tektronix
	Storage Tube Graphics	2	Tektronix	4012	Tektronix
	Intelligent Graphics	1	Tektronix	4051	PLOT-10, CALCOMP
Los Angeles District	Drum Plotter	1	CALCOMP	936	CALCOMP
	Storage Tube Graphics	1	Tektronix	4014	PLOT-10
Southwestern Division					
Albuquerque District	Drum Plotter	1	CALCOMP	921	CALCOMP
Little Rock District	Drum Plotter	1	CALCOMP	760	CALCOMP
Ft. Worth District	Drum Plotter	1	CALCOMP	936	CALCOMP
	CRT Plotter	1	Tektronix	4662	GCS
	Storage Tube Graphics	3	Tektronix	4014	GCS
	Storage Tube Graphics	1	Tektronix	4010	GCS
Galveston District	Drum Plotter	1	CALCOMP	563	CALCOMP
Tulsa District	Drum Plotter	2	CALCOMP	936/563	CALCOMP
	Storage Tube Graphics	1	Tektronix	4014	PLOT-10

GRAPHICS EQUIPMENT

	Equipment	# Units	Manufacturer	Model #	Primary Software Used
OCE					
DAEN-CWE-BA	Storage Tube Graphics	1	Tektronix	4014	GCS
DAEN-MCZ-S	Flatbed Plotter	1	Tektronix	4662	Basic
	Storage Tube Graphics	1	Tektronix	4014	FORTRAN
	Storage Tube Graphics	1	Tektronix	613	
	Intelligent Graphics	1	Tektronix	4051	Basic
EIDSO	Storage Tube Graphics	1	Tektronix	4014	PLOT-10, ENCORE
HEC	Storage Tube Graphics	1	Tektronix	4014	AG, IT, GCS
CERL	Storage Tube Graphics	1	Tektronix	4012	Mich Term System
	Intelligent Graphics	2	LSI-11	MX1200	Mich Term System
Coastal Engr Res Cen.	Drum Plotter	1	Benson-Lehner	305	Modified CALCOMP
	Storage Tube Graphics	1	Tektronix	4006	PLOT-10
	Storage Tube Graphics	1	Tektronix	4015	PLOT-10
CRREL-TS	Drum Plotter	2	Houston/Zeta	230	DEQ Zeta - 0518
	Flatbed Plotter	2	Tek/H-P	7004B	
	Storage Tube Graphics	1	Tektronix	4013	
	Others	1	Tektronix	4051	
WES					
Environmental Lab.	Storage Tube Graphics	2	Tektronix	4014	GCS
Pavement Design Div	Storage Tube Graphics	1	Tektronix	4014	
	Others	1	Hewlett Pack.	7200A	HPLOT
Computer Center	Storage Tube Graphics	3	Tektronix	4014	GCS
	Storage Tube Graphics	1	Tektronix	4012	GCS
	Intelligent Graphics	1	Tektronix	4081	PLOT-80
Structures Lab	Storage Tube Graphics	3	Tektronix	4014	GCS
	Intelligent Graphics	2	Tektronix	4051	GCS

GRAPHICS EQUIPMENT

	Equipment	# Units	Manufacturer	Model #	Primary Software Used
WES					
Structures Lab	Storage Tube Graphics	1	Tektronix	4014	GCS
Data Handling Br.	Drum Plotter	1	CALCOMP	563	CALCOMP
	Storage Tube Graphics	1	Tektronix	4014	CALCOMP/GCS
	Intelligent Graphics	1	Tektronix	4081	PLOT-10/GCS
Estauries Division	Drum Plotter	1	CALCOMP		
	Others	2	Versatec	D1100A	CALCOMP
Wave Dynamics Div.	Others	2	Versatec	D1100A	Versaplot
Math. Hydraulics	Drum Plotter	1	CALCOMP	563	CALCOMP
	Flatbed Plotter	1	HP		GCS
	Storage Tube Graphics	1	Tektronix	4012	GCS
	Storage Tube Graphics	1	Tektronix	4014	GCS

R&D ORGANIZATIONS

WES ADPC

3-D GRAPHICS

by

Fred T. Tracy

WES ADP Center

MOVIE BYU (Dr. Henry Christiansen, Brigham Young University) which plots three-dimensional (3-D) objects described by planar polygon patches is operational at WES. This software deletes hidden lines using the Watkins algorithm. Line drawings or continuous tone color plots can be obtained. 3-D contour lines can also be drawn (Michael Archuleta, Lawrence Livermore Laboratories). The hidden surface software has also been applied to plotting 3-D finite element grids.

A 3-D graphics module for the 3-D stability project (funded by the Computer Aided Structural Engineering (CASE)project) is now operational. This program allows the user to use basic building blocks to describe complex structures. The program then computes volume and centroid information for the structure. The graphics is used to generate, edit and view input data. The program has already been used to advantage in the Red River project studies by the St. Louis District.

GRAPHICS FOR COASTAL ENGINEERING APPLICATIONS

Lee Butler
WES, Vicksburg

Graphics play an important role in displaying numerical solutions to real-world engineering problems. Pages of printed numbers simply cannot relate the same message as a visual representation. Many of the new numerical modeling techniques for coastal hydrodynamic problems involve the solution of two and three-dimensional systems of equations which provide a simulation of a given phenomena. Presentation of these results may require various plot types to display the information in a meaningful manner. Examples of graphic results from hydrodynamic codes included in this presentation are: time paths of hydrographs at particular grid points, vector flow fields at selected [illegible] conditions as well as flow differences, contours of surface function over study region, contours of [illegible] topography, [illegible] three-dimensional views, [illegible] plots, [illegible] and [illegible]

WES HYDRAULICS LABORATORY

[illegible] microfilm, [illegible] color film, [illegible] printer plots, and pen plots (Calcomp).

GRAPHICS FOR COASTAL ENGINEERING APPLICATIONS

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Lee Butler

WES, Hydraulics

Graphics play an important role in displaying numerical solutions to read world engineering problems. Pages of printed numbers simply cannot relate the same message as a visual representation. State-of-the-art numerical modeling techniques for coastal hydrodynamic problems involve the solution of two- and three-dimensional systems of equations which provide a simulation of a given phenomena. Presentation of these results may require various plot codes to display the information in a meaningful manner. Examples of graphic results from hydrodynamic codes included in this presentation are: film plots of hydrographs at particular grid points, vector flow field plots of existing and plan conditions as well as flow differences, contours of stream function over study region, contour of area topography, color contoured flood representation, report ready plates, and movies of both flow movement and flooding. Output media includes 48X microfiche, 35mm B/W and color slides, 16mm B/W and color movies, line printer plots, and pen plots (Calcomp).

WES STRUCTURES LABORATORY

SAP PLOT (SAPLT)

by

Robert Cole
WES, Structures

SAPLT is a pre- and post-processor for the finite element code SAPV currently at WES. SAPLT is a batch code and produces drum or CRT plots of adjustable dimensions. It can create a wire drawing or a hidden line drawing of all the elements and of selected groups and/or selected elements. In the pre-processor mode, SAPLT can draw boundary elements, pile elements, 8-21 variable node points. It can also label node points and element group/element number/material type on the grid. In the post-processing mode, SAPLT can draw deformed grids or vector plots of static loadings, mode shapes, and response spectrums. For the direct integration option in SAPV, SAPLT can draw deformed grids for the displacement, velocity, and force fields.

WES ENVIRONMENTAL LABORATORY

FACTOR MAP DATA RETRIEVAL AND DISPLAY IN A CORPS PROJECT CONTEXT

by

Dr. Victor LaGarde

WES, Environmental Lab

A general procedure was developed for the recovery, processing, storage, and retrieval of factor map type data. The repository of the data is a very flexible master data file that accepts any number of different types of data. A single computer program that produces graphic displays of the data base contents is a basic tool for the project manager and analysts to use in quality controlling and analyzing the data. The program permits the retrieval of any types of data selected by the user. The user can specify any combination of AND/OR constraints on values of the data being retrieved or on its coincidence with other types of data. The geographic region for which data are retrieved is at the option of the user as well as the output graphic scale. The program was intended for use with drum and flat-bed plotters, but operates with any plotting equipment accepting CALCOMP plot function generated directions. A description of the program is given in the context of a specific Corps hydrologic and economic study.

AUTOMATED CARTOGRAPHY DATA FORMATS AND GRAPHICS: THE ETL EXPERIENCE

The relationship between hardware and data formats is an important consideration in the design of a digital cartographic system. The use of a variety of hardware systems in the collection and output of data complicates the design of a data base even though such variety necessarily improves the input/output aspects of the system. This paper briefly discusses such relationships between data formats, hardware, and cartographic products and describes a number of cartographic systems which differ widely in their mode of operation. No magic formula is offered for incorporating all of them into a single total system at the present time.

Linear-Versus-Raster Formats. At ETL we have been concerned with two basic forms of digital cartographic data. These might be described as "linear" data and "raster" data. "Linear" format refers to a string of X,Y points defining the path of a line. This is the type of data generated by tracing with a typical X-Y digitizer. "Raster" format refers to information stored in an array of pre-defined cells. A drum scanner produces raster data. Computer processing of raster data is normally much more complex and costly than the processing of the linear data. Raster hardware, however, offers greater efficiencies in digitizing and plotting than linear hardware.

Linear Data Handling Techniques. For storage and processing of linear data, vectorial representation has been found to be the most efficient technique for a number of reasons. The type of vector coding used allows representation of a random line by means of a series of pre-defined vectors, each of which represents a fixed X,Y direction and distance as shown in figure 1.

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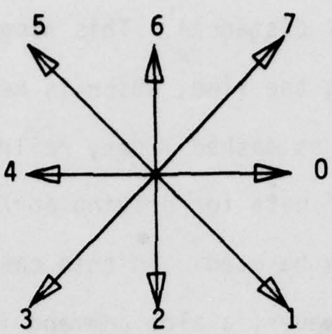

Figure 1.

Each vector may be assigned a single 3-bit digit for identification. A linear feature is then described by giving the X,Y coordinates of the start point followed by a string of vectors. The line can be reconstructed by using the vector codes to address tables of X and Y incremental distances which are added to the absolute start point coordinates. While this requires much less tape or disc space than storage of complete sets of X,Y coordinates, there are other advantages to this format as well, including convenience for transformation and symbol production and facilitation of efficient plotting.

Data transformation, which may require scaling and/or rotation of coordinates, can be made more efficient by first transforming the vector pattern. Then only the absolute coordinates of each feature's start point need be transformed. Since the distance represented by each vector has been modified by the transformation, vectors may be added to the absolute start point to con[illegible] the feature in the usual manner.

In developing certain types of li[illegible]ar map symbols, the vector codes may be used to address a table of absolute distances (as opposed

to an X distance and a Y distance). This simplifies the task of measuring distance along the line, which is necessary in drawing such repetitive symbols as dashed lines, railroad tracks, etc.

In the generation of data for driving an X,Y plotter, a simple data thinning scheme may be used. In this case, the X,Y distances are added as usual. However, a plot command is only issued when the current vector differs from the previous vector. A satisfactory approximation of the line may thus be achieved. This will normally result in a decrease in both computer and plot time.

The Digital Input/Output Display Equipment (DIODE) system currently being integrated into production at the Defense Mapping Agency Topographic Center has been designed to operate with vector data as described. This system is designed to provide an interactive capability for revising and updating map data and includes a DEC PDP 11/45 computer with 128K words of core, disc and tape units, and a graphics console consisting of a Bendix Datagrid Digitizer, a Lundy 32/300 CRT Display System, and a Tektronix 4014 storage tube display.[1] Map data are broken down into 2.5-X 1.875-inch pages to make display on the refresh CRT possible. Map revisions made with the digitizer are visible on the refresh screen in real-time while the storage tube display offers a cumulative inventory of progress.

<u>Raster Data Handling Techniques</u>. Raster hardware may offer advantages in speed and accuracy when compared to linear oriented systems. However, processing such data is a major problem, due in part to the large amount

of data generated by raster scanning. The ETL's currently experimental drum scanner plotter is capable of scan resolutions of 0.001, 0.002, and 0.004 inch (0.0254, 0.0508, and 0.1016 mm). Thus, in considering a typical input graphic of 24 x 30 inches (60.9 x 76.2 cm), the total number of points generated can vary from 720×10^6 to 45×10^6 depending upon the resolution chosen.

In scanning a line graphic (as opposed to a continuous tone product such as a photograph), the amount of data generated can be greatly reduced by run-length coding. Under this scheme, only line crossings are recorded, thus eliminating the large amount of data that might otherwise be used to record blank spaces. With the ETL drum scanner, the circumferential location of a line crossing is recorded as the spot (resolution element) count between the leading edge of the document and the line. One tape record is recorded with each drum rotation. Axial position of a line crossing can then be developed by counting the number of prior tape records and multiplying by the scan resolution used. Since the scanning aperture must obviously be smaller than the smallest point to be digitized, a line crossing is actually recorded as two points. The first point is the transition from "white" space to line image, with the second point the transition from image to "white" space. Using this type of run-length coding, a data compaction of 7 to 1 as compared to the standard binary coding technique is considered normal. As the amount of data on the input graphic increases, achievable data compaction decreases.

In a further effort to solve the raster data processing problem, a different type of computer hardware, the "STARAN" Associative Array Processor is also being investigated. Figure 2 shows a test map produced via STARAN processing. Input to the ETL scanner/plotter consisted of 11 hand-drafted manuscripts (0.018-inch inked lines on 0.004-inch drafting mylar), each manuscript representing a separate class of data (i.e., first class roads, second class roads, etc.), as shown in figure 3. Data were scanned and digitized at 0.004 inch (0.1016 mm) resolution. Computer processing was performed separately for each class of data to accomplish line thinning, raster-to-vector conversion, automatic editing, symbolization, merging of files, and raster plot tape generation. In addition to the symbolization of the 11 data files, it was necessary to generate files for first and second class road fill and to use certain files to suppress portions of other files. For example, road files were used to blank out the woodland pattern wherever the two files coincided. This might be referred to as priority merging, in that one class of data has priority over another for the same space.

While the "STARAN" Associative Array Processor was used to process all data for this map sheet (with the single exception of the names data), a parallel effort was also made using a CDC 6400 computer to obtain comparison times on a large-scale sequential processor. The total time to process the Lake Istokpoga data on the CDC 6400 computer was 149 minutes (75 minutes CP time, 74 minutes I/O time), whereas the STARAN took 39.6 minutes (3.4 minutes CP time). The STARAN time was recorded for a tape input/output system, and it has been estimated that a disk I/O system should provide an additional 7X reduction in

total STARAN time (for example, 5.6 minutes versus 39.4 minutes). Future work plans call for processing the same data on the STARAN using 0.002-inch and 0.001-inch spot sizes. From these results more complete indicators of cost versus quality can be determined.

Mixed Mode Efforts. Two systems currently under development, a modified X,Y plotter and an Electron Beam Recorder, make use of both vector and raster data formats in a mixed mode operation. The plotter modification, applicable to both the Gerber and Concord precision plotters, consists essentially of a 5-inch (12.7 cm) diameter cathode ray tube mounted on the plotter carriage, controlled by a DEC PDP 11/45 computer. The CRT is focussed on the plotting surface and is used in place of, or in addition to, the light drafting head normally furnished with the plotter. A plotting head system of this type is currently being procured for each of the Defense Mapping Agency production centers.

The primary advantage provided by the CRT plot head is the ability to plot a variety of map symbols rapidly under computer control, without making the photographic masks normally required with conventional light heads. Alphanumerics and symbols are stored in digital form on replaceable disc files in the control computer. In operation, the plotter head is driven to the approrpiate X, Y position, and the desired digital data is retrieved from the disc and used to drive the CRT. In order to achieve maximum flexibility in preparation of input data, the characters and symbols on disc are stored in a raster format (figure 4). This storage format is sometimes referred to as a sub-raster, since a separate raster is stored for each character or symbol. This format allows the digital file to be created and updated by using a commercially available scanner to digitize the desired graphic, which

may consist of an alpha character set, map symbols, or any type of discrete symbology desired. Figure 5 shows a names overlay prepared on the CRT plotting head.

Investigations are also being made as to the feasibility of plotting complete color separations (linear as well as "spot" symbols) in a paging mode as shown in figure 6. Here each "page" represents the area covered by the CRT, which is 2.5 x 2.2 inches. Digital data which have been paged for storage and display purposes can be output by plotting each adjoining page in its entirety until the total map area is covered. Tests with data of this type indicate that a typical color separation can be plotted in less than 10 minutes.

An updated Type Composition system, which will produce data for input to the CRT plotting head system, is also under development. The latter will include a minicomputer with an on-line digitizer and two video display terminals. Names data to be digitized are first prepared by a cartographer on a draft manuscript. Names from the manuscript are then typed into the system using one of the video display terminals. For input, the map is divided into vertical strips so the console operator can input names by scanning down each strip. The names are then displayed, in the same order as input, on the console associated with the X,Y digitizer. The digitizer operator, using the cartographer's manuscript as a guide, generates an X,Y coordinate for the location of each name by moving a cursor to the desired location. He may also input angular deviation if the name is not to be horizontal. A rectangle may then be plotted back immediately to indicate the amount of space occupied by the name. The control computer merges the names and placement data and outputs a tape containing information

as to the location, spelling, and type style and size of each name. A scan head is also being evaluated as an alternative way to input data and may prove to be more cost effective than manual entry for each name or symbol. In order to facilitate plotting, the names data are paged by the plotting control computer. This procedure minimizes plotter head movement and reduces plotter time.

Another development utilizes the Cartographic Electron Beam Recorder. This is a cathode ray tube microfilm plotter in which the electron beam impinges directly upon the film. There is no phosphor screen as in a normal cathode ray tube system. This streamlining removes a major source of image distortion and makes possible the drawing of lines as thin as three micrometers, since thereis no light-emitting phosphor involved. The ETL system will handle film widths from 35 mm to 5½ inches (139.7 mm). Line images can be plotted in either a vector or raster mode, depending upon the software used with the on-line control computer. Emphasis has been on development of a vector drafting capability because of the less demanding software and computer requirements. When plotting in the vector mode, lines of varying thickness are generated by applying a circular motion to the beam as it is moved along the desired line path. In addition to line drawing capabilities, the EBR can produce continuous tone outputs having up to 256 shades of gray in the raster plotting mode. Table 1 lists some additional characteristics.

Table 1. Cartographic EBR Performance

Film Sizes (mm)	140, 70, 35
Image Formats (mm x mm)	127 x 203, 65 x 86, 24.6 x 37.3
Beam Diameters (m)	3 & 6
Beam Addressability	32, 768 x 32, 768
Vector Plotting Speed (points, second)	125,000
Line Width Control (m)	3 - 250
Character Sizes (points)	4 - 36
Character Generation Speeds (characters per second)	
5 - 8 points	1360
10 - 18 points	450
36 points	225
Character Rotation	0 - 359^{o} increments
Raster Scan Rates	Variable up to 2kH$_{Z}$
Dynamic Range (gray shades)	64
Optical Density (D_{max})	2.3+
Video Bandwidth (MH$_{Z}$)	10
Congruity of Sequential Images	0.003%
Geometrical Fidelity	0.01%

While the Cartographic EBR is, at present, a developmental system, it offers a number of possibilities for use in the mapping community. The capability for handling the 5.5-inch wide film makes possible the production of full-size reproduction films for aircraft approach charts which are nominally 5 x 8 inches (127 x 203 mm). Figure 7 shows such a film image produced on the EBR. Most of the information shown consists of simple geometric shapes and alphanumerics, making the design of a digital data base for chart production and update simpler than it is when using larger, more complex standard maps. The fact that these charts must be updated each month makes some type of automated production/update system highly desirable.

Color separations produced at 5 x 8 inches for 1:50,000 scale topographic maps require only a nominal 4X enlargement. A complete set of separations for a 5-color map will be prepared and printed full size as part of ETL's test of the EBR.

The EBR can, of course, produce various microfilm and microfiche products for archival purposes. In addition, the accuracy and resolution are sufficient for production of microfilm color separations. Obviously, such color separations are useful only if some means is available for enlarging the image to map size, while retaining the necessary quality. An experimental system is currently being assembled at ETL (in breadboard form on an optical bench) to evaluate the problems involved in making lithographic press plates directly from projected microfilm. This system uses an argon laser as the light source. The color separation, placed in the laser path, modulates the light striking the plate. The laser beam can be scanned in various patterns to cover the required image area. A system of this type promises substantial film cost and archival storage space savings.

Another approach to digital press plate production is also under development. This approach will include hardware capable of scanning an input graphic and producing a press plate via laser or other high intensity light source exposure in real-time. In addition, the plate making portion of the system will also accept digital data prepared off line. The system can thus be used to produce a plate from existing hardcopy or from data stored digitally. The system will handle copy and plates up to 48 x 60 inches with a maximum scan time of 15 minutes.

Terrain Elevation Data Handling Techniques. Because of the great amount of data involved, the storage and manipulation of terrain elevation data present special problems. Such data may be generated in linear or raster form depending on the compilation technique used. Data stored as digitized contour lines, while reasonably efficient in terms of storage media, cannot readily accommodate uses other than recreation of the contours. A more useful format, currently in use, involves storage of a matrix of spot elevations. Data compiled in linear form is converted to matrix form. Since the relative X,Y location of a point is implied by its matrix position, it is not necessary to store an absolute X,Y for each point. Data of this type can be used to generate contours at different intervals and scales, shaded relief patterns, and a number of other related products. A typical 1:50,000 scale map stored at the usual resolution (1 point per 0.01 inch at map scale) requires in excess of 3 million points under this format.

A more compact form for storing elevation data is obviously desirable, assuming the data are still as accurate and readily usable as the matrix form. Numerous techniques, including modeling based on high- or low-order polynomials, trigonometric functions, irregular networks, and spline functions, have been investigated as possible desirable alternative storage formats. Based on ETL investigations, a terrain model using low-order polynominals appears to offer significant advantages over other techniques.[2] This method requires the least-squares determination of a set of variable length, low-order polynomial coefficients with each polynomial centered over a grid point. Minor modifications

to standard least-squares procedures are included to allow for automatic removal of extreme compilation errors. Special weighting functions are used to interpolate between the polynomials, insuring accuracy and continuity of the terrain model when it is used. Development of this Polynomial Modeling Technique is essentially complete except for final definition of the data compression method to be used on the polynomial coefficients. Preliminary results indicate a compaction of 80 to 1 over the presently used techniques.

In addition to developing more efficient software techniques for storing elevation data, ETL is interested in improved hardware for this purpose. Optical digital encoding of data onto video-digital discs has great potential. Initial calculations shows that over 6,000 terrain maps (1:50,000 scale) could be stored on a single 12-inch diameter flexible film disc. ETL is following optical digital developments within the Department of Defense, so that we may apply this rapidly emerging technology as soon as possible. Electron Beam Recorders have been used to prepare disc masters for video discs and the ETL Cartographic EBR has potential for use in this area wherein maps and map production materials may someday be stored in both analog (graphic) and digital form on the same optical record. This would obviously result in new data formats as well as new capabilities.

SUMMARY.

This paper has briefly described some of the automated cartography developmental work being carried on by ETL, with emphasis on the variety of formats, both digital and graphic, involved. This variety results from an effort to keep up with the state-of-the-art and to evaluate

the various approaches available to produce a given end result. While primary emphasis has been given to production of standard military maps, the capability exists for producing a great variety of products, both graphic and digital, using techniques of the type described. More interaction between the map producers and the map (or data) users is needed to fully exploit the capability available. This is seen as a long-term educational process for both groups. Standardization of data formats and exchange of data between users is complicated by the constantly advancing state-of-the-art (assuming that one wishes to take advantage of the most advanced techniques). It is to be expected that as more people become familiar with and proficient in working with digital hardware and software, such problems will be minimized.

REFERENCES

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CERL

Graphic Techniques in Automated Architectural Design Evaluation

by
Janet Spoonamore
R. Bruce Dains

Department of the Army
CONSTRUCTION ENGINEERING RESEARCH LABORATORY
P.O. Box 4005
Champaign, IL 61820

Abstract

In this paper we present graphic hardware and software techniques for entering and displaying architectural plan drawings in an interactive mode. These methods have been incorporated into SEARCH which will be used by Corps District Offices.

Foreword & Acknowledgments

SEARCH, Systematic Evaluation of ARCHitecture, is an automated system for evaluating architectural designs. The system is being developed at the U.S. Army Construction Engineering Research Laboratory under the general supervision of Mr. Edward Lotz, Chief, Facilities Systems Division and is part of the effort within the Facilities Systems Planning Team led by Mr. Raymond Larson. COL James E. Hays is Commander/Director of CERL and Dr. L. Shaffer is Technical Director.

CERL's telephone number is: Commercial 217-352-6511 and FTS: 958-7315. Correspondence may be addressed to U.S. Army CERL, ATTN: Ms. Janet Spoonamore, P.O. Box 4005, Champaign, IL 61820.

Introduction

SEARCH, Systematic Evaluation of ARCHitecture is a computerized tool for evaluating architectural designs. Development of the user interface in SEARCH was constrained by Corps users having widely varying backgrounds in computer use. Few will have much experience with graphics. In developing the system hardware and software, we explored new configurations and methods which reduce the tedium involved in graphic entry and display. Our findings show that an integrated terminal (consisting of a graphic display, hard copy alpha-numeric printer and

digitizing board) supported by Menuing and display routing software improves user performance in handling spatial information.

Background

Corps district personnel, evaluating the functionality of architectural designs are most concerned with the spatial allocation and arrangement of the facility. Criteria for which the designs must conform include room area requirements, desired proximity of rooms and visual access from one room to another. The spatial data required to determine conformance consists of the positions and dimensions of the walls, doors, windows and floors of the building. The scope of this presentation covers the entry and verification of this spatial data.

Problem

SEARCH users, Corps District architect-reviewers and technicians, have varied backgrounds in computer experience. They will be responsible for entering the architectural drawing into the computer and assure its proper representation. We presumed that less experienced users would need simple, straightforward procedures which would reduce learning time, tedium and errors. These then became the objectives in developing the user interface for SEARCH spatial data entry.

Hardware

Defining the local graphic workstation requirements involved analyzing user tasks.

1. Input. Users must enter both graphic and alpha-numeric data. Firstly, a digitizing board large enough to accomodate E-size drawing and several menus of commands provides for graphic data input. Secondly, a standard keyboard, upper/lower case provides for keyed alphanumeric data input.

2. Output. Users require graphic output as well as convenient hard copy. The graphic display screen, in this case a storage tube, serves the graphic needs and a standard alpha-numeric printer provides hard copy. Graphics hard copy is available either by using a hard copy scanning unit or by taking a photograph of the screen.

3. Integration. The users must have immediate access to both forms of input and both forms of output. This is to say, an integrated terminal work station must be configured. At his convenience the user must be able to enter using either the keyboard or the digitizing board. We found it imperative that this flexibility be maintained which caused some problems in selecting a digitizer. The standard digitizer which accompanies the most popular storage display screen must be pre-armed from the computer software. This allowed for no user freedom. Fortunately, we found two tablets which could be continuously armed allowing

free input from both the keyboard and digitizer even within input command strings. Graphic displays are to be routed to the graphic output and text output is directed to the hard copy printer. Below are listed the alternative options which must be provided.

User:	Phone:
digitizer	printer (escape switch)
keyboard printer	graphic (escape switch)
keyboard graphic	

Digitizer:

graphic (local and escape switch)

printer (local and escape switch)

phone (remote)

keyboard-graphic:	keyboard-printer:
graphic (local)	printer (local)
phone (remote)	phone (remote)

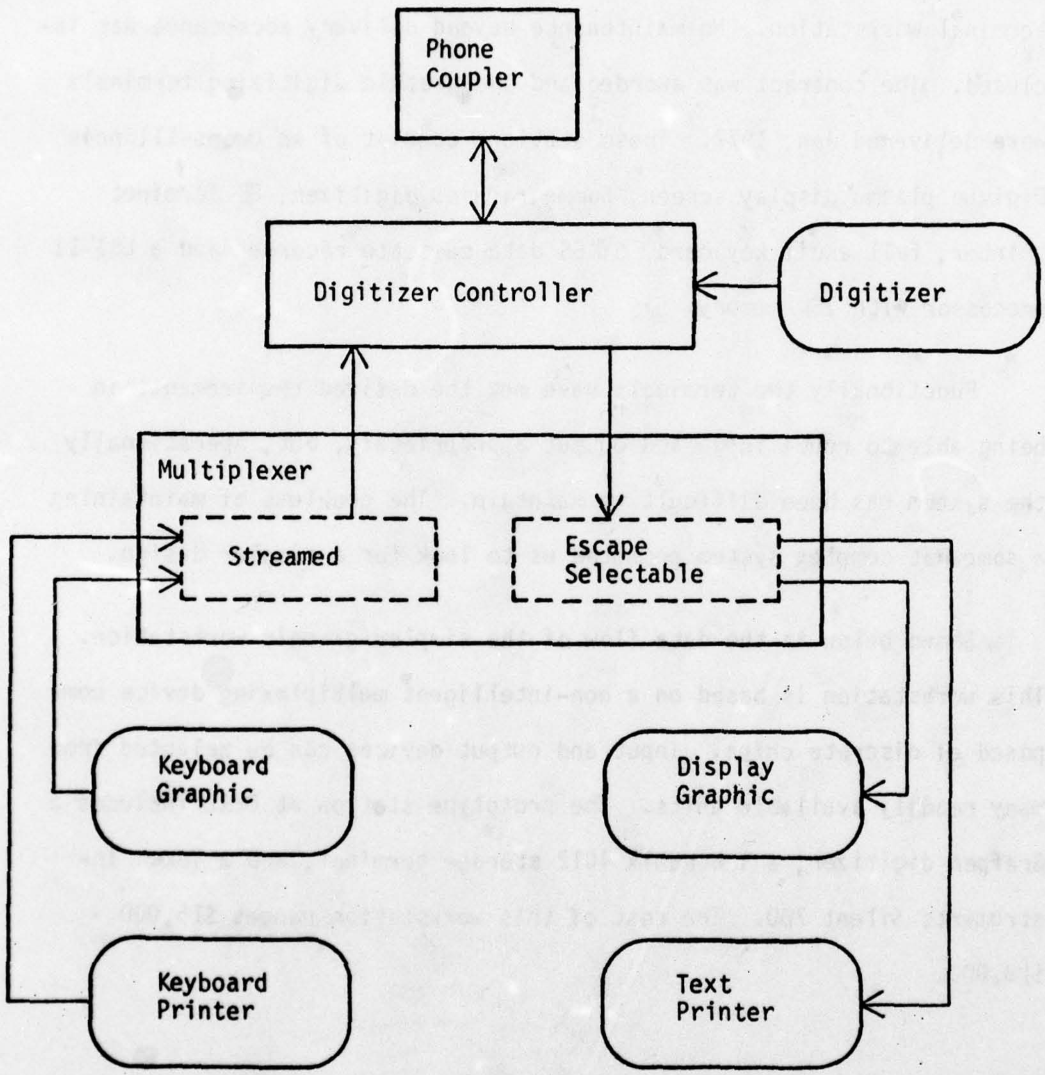
4. Costs and Availability. We explored the market to assemble an integrated system of components for our graphic workstation. The major companies, Tektronix, Digital Equipment Corporation, Magnavox and others could not provide the shelf equipment to assemble and integrate the terminal.

In 1976, we developed a scope of work and solicited for two graphic digitizing work stations. The two bidders both proposed systems based on LSI-11 processors. The costs, including all equipment, design, assembly, and software implementation, ranged \$22,000 - \$25,000 for each terminal workstation. No maintenance beyond delivery acceptance was included. The contract was awarded and the graphic digitizing terminals were delivered Jan, 1977. These stations consist of an Owens-Illinois Digivue plasma display screen, Summagraphics digitizer, GE Terminet printer, full ascii keyboard, SYKES data cassette recorder and a LSI-11 processor with 18K memory.

Functionally the terminals have met the desired requirements in being able to route input and output appropriately, but, operationally the system has been difficult to maintain. The problems of maintaining a somewhat complex system prompted us to look for a simpler design.

Shown below is the data flow of the simpler graphic workstation. This workstation is based on a non-intelligent multiplexing device composed of discrete chips. Input and output devices can be selected from many readily available units. The prototype station at CERL includes a Grafpen digitizer, a Tektronix 4012 storage terminal, and a Texas Instruments Silent 700. The cost of this workstation ranges \$15,000 - \$18,000.

DATA FLOW


Phone Coupler
Digitizer Controller
Digitizer
Multiplexer
Streamed
Escape Selectable
Keyboard Graphic
Display Graphic
Keyboard Printer
Text Printer

Software

The software to support the SEARCH graphics has been developed on the University of Michigan, MTS system, Amdahl 470. The two functions, graphic input and graphic output, will be discussed.

a. Graphic Input. Digitizing architectural drawings for SEARCH evaluation requires entry of room and door vertices. Interaction with SEARCH system commands and entry of room names must be provided during the digitizing of the drawing. Using a menu of commands and a menu of room names located on the board with the drawing allows for a more convenient handling of entry tasks. The user may enter all commands, names of rooms and room and door vertices from the digitizing board.

The SEARCH menuing software is based on the SCAN[1] system developed at the University of Illinois. Menuing of input was incorporated to this standard Fortran package.

b. Graphic Output. As each new room/door is entered, its figure and label is displayed for verification. Options are provided to establish frames of view to display all or any part of the building. Command text is routed to the printer in order to avoid cluttering the display.

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1 SCAN User's Manual, A Free Form Input; Subroutine System, Civil Engineering Systems Laboratory, Dept. of Civil Engineering, University of Illinois, Urbana, IL, Sept 1976.

SEARCH graphic display software is based on the MTS Integrated Graphics System[2] general purpose graphics system. Using these routines allowed for convenient development of graphic handling. We incorporated routing options to transfer all text information to the printer.

2 "Integrated Graphics System Users Guide", Computing Center, University of Michigan, Ann Arbor, MI, March 1977.

Entry of Plan Drawing

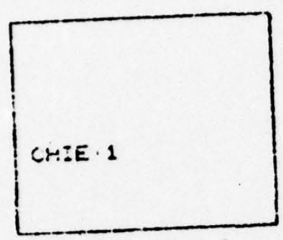
The user enters the plan drawing in an interactive mode. The major steps in the process are orienting the menus and the plan on the digitizing board and one by one digitizing the rooms and doors of the building. The example which follows illustrates the user interaction in this process. In this example, computer responses are shown in upper case, user responses are shown in lower case, and annotation is shown in italics.

access	erase	pass	;	0.0
acoustic	evaluate	prnt_menu	*	0.25
activity	files	quit	>	0.5
actmax	floor_ht	rename	#	0.75
add	frame	report	:	1.0
area	get	save		2.0
both	group	setup		2.5
brief	label	space		3.0
cancel	last	spcmin		3.5
control	main	un_group		4.0
criteria	mount	view		5.0
delete	new	walk		6.0
demount	no	wall_tk		7.0
display	no_label	yes		8.0
door	old			9.0
draft	oops			10.0
				20.0
				30.0

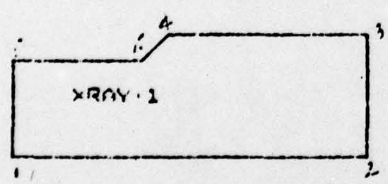
Example

DRAFT: mount main	*The user orients the command menu on*
ENTER MOUNT POINTS	*board by 3 points: lower left, upper*
point 1	*left and upper right.*
point 2	
point 3	
MOUNT COMPLETE	
DRAFT: mount activity	*Henceforth, the user points to*
ENTER MOUNT POINTS	*words on the command menu.*
point 1	
point 2	
point 3	
MOUNT COMPLETE	*Menu of activity names is mounted.*
DRAFT: setup	*Orienting the drawing by hitting*
point 1	*points of scale line, length*
point 2	*in feet, register point.*
116.5	
point 3	
SETUP COMPLETE	
DRAFT: frame	*Describe view window. The graphic scree*
point 1	*is erased and text is routed to printer.*
point 2	
DRAFT: space	*Begin to enter rooms.*

SPACE: chief	*Hit word, CHIEF, name of space.*
point 1	*Hit opposing corners of diagonal.*
point 2	
label	*Show where label is to displayed.*
point 3	
AREA OF CHIEF: IS 135 SQ.FT.	*Display shows room: CHIEF.*



SPACE: xray	*Enter next space, XRAY, which is non-rectangular. All corners are hit.*
point 1	
point 2	
point 3	
point 4	
point 5	
point 6	
label	*Indicate position of label.*
point 7	
AREA OF XRAY: IS 100 SQ.FT.	*Display shows new room: XRAY.*



SPACE: Last

DRAFT: door

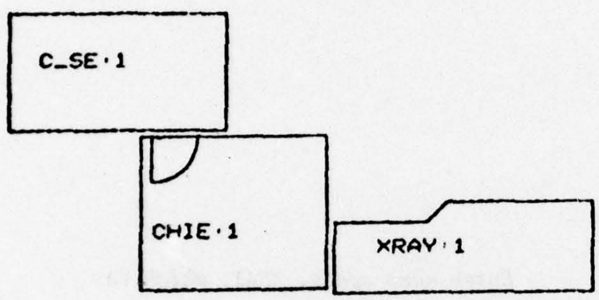
ENTER DOOR:

point 1

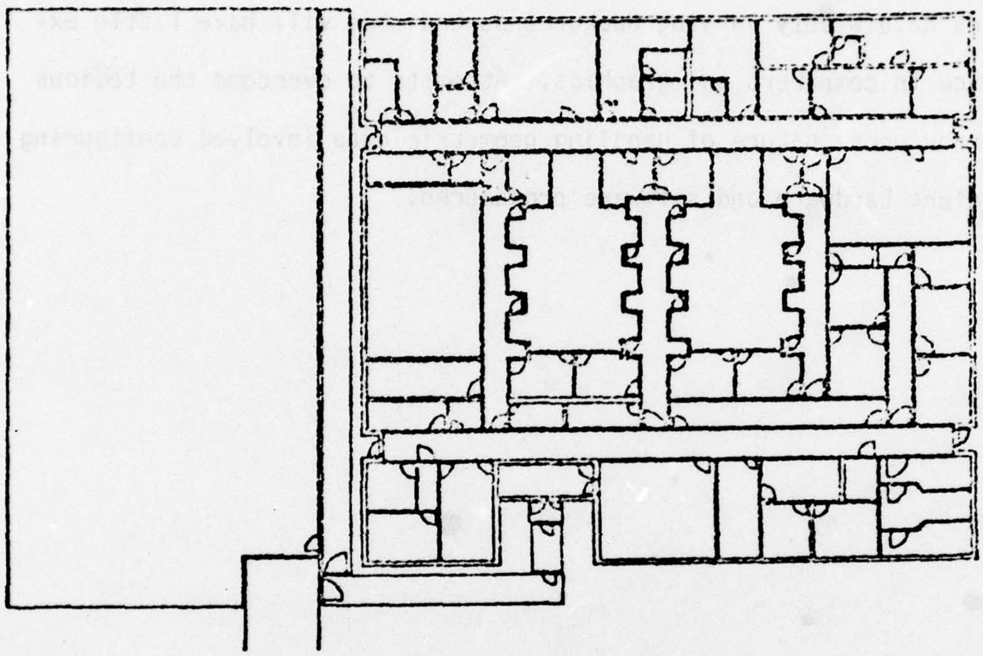
point 2

point 3

Exit from space entering. Enter a door between CHIEF and C SECRETARY. Hit 3 points, the latch, hinge and direction of swing.



At any time during space and door entry, changes may be made to correct errors. Spaces and doors may be removed and re-entered. The drawing shown illustrates the completed representation.



Summary and Conclusions

The user interface for SEARCH spatial data entry relies upon sensitivity to the personnel using the system. These architects and technicians have widely varying backgrounds and some will have little experience in computers and graphics. Attempts to overcome the tedious and error prone nature of handling geometric data involved configuring convenient hardware and software procedures.

INTERACTIVE WORKSHOP

Interactive Graphics Session

Co-Chairman - Robert Hall/Bob McMurrer/Don Phillip

The interactive sessions were devoted to demonstrations from eight different offices using a variety of graphics equipment. The following are brief descriptions of these presentations.

GRAPHICS AT SLD

25 Aug 78

In order to demonstrate one phase of graphics usage in the St. Louis District, Gerald C. Willick of the St. Louis ADP Center, displayed part of his Instrumentation Data Reduction System. This system written to interface the WES G635 (FORTRAN) with the Tektronix 4051 (Basic), is used to reduce instrumentation data (piezometers, subsurface settlement plates, surface reference monuments) and to produce deflection vs time plots for evaluation of structural performance. The plot format is in accordance with the requirements of ER 1110-2-100 and DIVR 1110-1-310.

Another SLD application of graphics is in the area of structural analysis of pile foundations. An interactive programs used to generate and display pile geometry data for input to a number of rigid base pile analysis is in the final stages of development. Additionally, an interactive post plotting program is being developed to display the results from both flexible and rigid base analyses. Both of these programs, written by John J. Jobst, utilize GCS and will be available for the G635, G6000, and CDC 7700.

Gerald C. Willick

Gerald C. Willick
AC-S

HIGHWAY PERSPECTIVE AND FORMS PLOT INTERACTIVE SESSION

During the interactive session, Mr. Daryl J. Bradstreet of the Seattle District demonstrated the "Interactive Highway Perspective Plot" and the "Forms Plot" programs.

The Highway Perspective program plots designed roadways and original groundlines in perspective from any viewpoint referenced to roadway station and centerline.

The program requires a data set generated by the Roadway Design System (RDS) that contains the X,Y,Z coordinates and a point code for each point on each cross-section.

It is installed on the North Pacific Division IBM 370/155 computer and is executed interactively under the IBM Time Share Option (TSO) in a 180K region. The plot is drawn on a Tektronix terminal 4014.

The "Forms Plot" program plots card-image type forms that are used to code data to be punched on computer input data cards.

The input to this program is a data set that describes the form to be plotted. It contains information such as form, lettering and column sizes. It also specifies the card-image line by fields which are indicated by beginning and ending column numbers. Each field may have a descriptive heading which is automatically sized to fit within the specified column range. Any number of card-image lines may be plotted on one form.

This program is installed on a Harris 120 minicomputer in the Seattle District. One version executes in a batch environment to produce final Cal Comp plots of the form. Another version contains Cal Comp preview software which allows the program to be executed from a Tektronix terminal connected to the Harris with a 9600 baud line to produce immediate plots. This version is used to debug the input data and get the preliminary form into shape for final plotting.

This program is not a truly interactive program. It requires the input data in card image form to be saved on a disc data set for input during execution. Response is extremely good on the Harris and no conversion to an interactive type program is foreseen at this time. It should be noted, however, that with a slower line speed the Tektronix version would be come impractical due to the large amount of lettering required for each form. Each letter is comprised of many short line segments that require a great deal of time to draw at a transmission speed less than 9600 baud.

Any questions regarding either program may be referred to Mr. Bradstreet by telephoning FTS 399-3696.

COMPUTER GRAPHICS COLLOQUIUM

Waterways Experiment Station
1-3 August 1978

Interactive Graphics Demonstration Session

Topic: On-Line Digitizing On Large Remote Mainframe

Software System:

Title: Hydrographic Survey Software System

System Number: 73383080

Sponsoring Office: Nashville Engineer District

Author: Sam Bradley, Civil Engineer

Hardware:

Computer System: CSC Infonet UNIVAC 1108

Terminal System: Tektronix 4014 Graphics Terminal
Tektronix 4954 Graphics Tablet
Tektronix 4631 Hard-Copy Unit

Communications System: Bell 212A Modem operating at 1200 Baud

Introduction:

This software was needed to transform small to medium quantities of hydrographic survey data to topographic (contour) maps. Large quantities of data could best be handled by fully automated systems such as those used by the Memphis and Wilmington Districts.

Overview:

This software system consists of three (3) programs. The first program is for developing a data base from field survey party notes of the streambank baseline and from fathometer chart paper of the stream cross-sections. The second program converts the data base to the input format needed by Calcomp's General Purpose Contour Program (GPCP II).

The third program GPCP II, produces the final engineering size drawings, ready for review and approval.

Description of First Program:

The first program gives the user the capability to create and completely edit a data base. The program is written in modules for easy loading onto minicomputers in overlay form. The following data handling options are envisioned for the complete system.

Baseline Data:

(1) Add data

(2) Delete data

(3) Insert data

(4) Change data

(5) Display data

Fathometer Range Data:

(1) Add data

(2) Delete data

(3) Insert data

(4) Change data

(5) Display data

Description of Second Program:

Using the data base created by the first program, the second program dissects the data into segments that fit onto engineering size drawing sheets. The data is rotated in space to display the maximum amount of data on the page. These data segments are then reformatted to be accepted by Calcomp's GPCP II.

Description of Third Program:

The third program is the standard version of Calcomp's General Purpose Contour Program (GPCP II) with one minor modification. The "LINE" input record was changed to allow the X & Y coordinates to be larger than 5-digits long.

Economic Considerations:

In an effort to assure the user that all data is received accurately, the first program performs a great deal of graphics on the terminal screen in the same format as it would be represented if it were drawn manually. It has been our experience that this form of data display is only expensive when accompanied with extensive labeling (E.G. Station numbers displayed as 83+21.47). We also found that the use of the graphics tablet for data input in digital form is probably the cheapest means of reducing fathometer chart information.

Considerations For Conversion to Other Hardware:

Conversion to any hardware the size of a DEC 11/70 minicomputer or larger should represent no real problems for the first and second programs due to the software being developed in a modular form. The extremely large size of the third program may cause addressing problems for any machine using a standard word size of less than 24 bits. This would be true whether the machine has virtual memory or uses overlays to run large programs.

The first program is completely interactive in operations. Therefore, how each operating system handles I/O interrupts becomes very important. The deficiencies of some operating systems (such as in CDC equipment similiar to that operated by the current TSP Vendor,

Boeing Computer Services) becomes very critical in digitizing data. When converting to such systems, consideration needs to be given to procedure for inputing digitized data from the graphics tablet. I/O interrupts should be less critical in minicomputers, such as the one in the Wilmington District, due to the limited number of terminals (generally less than 10) in use at any one time and a more cooperative operating system.

Current Stage of Development:

As of 15 August 1978, the following options are available in the first program:

Baseline Data:

(1) Add data

(2) Display data

Fathometer Range Data:

(1) Add data

(2) Delete data

(3) Insert data

Both the second and third programs are complete.

Documentation:

Currently, no documentation has been developed for the first and second programs. Documentation is available from Calcomp for the third program. Since the first program is completely interactive and is the only part that the user interfaces with, use of the system is not dependant on availibility of documentation.

DEMONSTRATION OF MAPPING TECHNIQUES USING THE TEKTRONIX MODEL 4081 INTERACTIVE GRAPHIC SYSTEM

By

J. L. Smith

29 August 1978

Data Handling Branch
Mobility Systems Division
Geotechnical Laboratory

Demonstration of Mapping Techniques Using the Tektronix Model 4081 Interactive Graphic System

The launch in late 1972 of the first of NASA's Landsat satellites caused a little known technology--image data processing--to be pushed to a position of prominence at the WES. The result has been an evolution of concepts and techniques for image enhancement, remote sensor data interpretation, map production, and data base manipulation. The Tektronix Model 4081 interactive graphics system embodies in its scan graphics capability the means to dynamically and interactively exploit these concepts for the real time observation, manipulation, and output of digitized imagery to produce a number of photographic effects and products.

The demonstration showed how interactive scan graphics can be used to extract meaningful geometric and radiometric information from digitized image data, interpret the data, and depict the results as images on the interactive display ready to produce photographic images, maps and charts. Specifically demonstrated were the image data processing techniques for mapping the distribution of suspended material, the inventory of water impoundments, and time dependent change detection along the Mississippi River. A description of these demonstration projects follows.

The spectral sensitivity of the multispectral scanner aboard the Landsat has been exploited to map the distribution of suspended materials in water bodies. During the 1973 flood in the Lower Mississippi River Valley, the Bonnet Carre Floodway connecting the Mississippi River with Lake Pontchartrain, Louisiana, was opened. This action resulted in a large flow of sediment-laden water from the Mississippi River into Lake Pontchartrain, causing great concern over the impact this would have on the fishing, shellfish, and transportation industries and the ecology of Lake Pontchartrain in general. A massive data collection program was launched to acquire information on the quality of sediments being transported and deposited in Lake Pontchartrain. Landsat data taken for Lake Pontchartrain and vicinity were correlated with these data, and a reference library of spectral signatures related to suspended material

concentrations was derived. The spectral signature of each picture element was then compared with each signature in the reference library. When a match occurred, the picture element was identified with the reference spectrum that it matched and, hence, the suspended material concentration in the area covered by the picture element. The results produced a suspended material distribution map showing the influx of suspended materials from the Mississippi River into Lake Pontchartrain via the Bonnet Carre Floodway.

In late 1972, the Corps of Engineers was charged with responsibility for inventorying 50 acre-ft or larger water bodies in the United States. Experience with Landsat digital data had shown that band 7 provides a clear separation of land and water except in cases where an area is covered with haze or clouds. Consequently, by a relatively simple process of identifying each picture element in a scene as land or water on the basis of band 7 radiance value, and then writing a picture with water bright and land dark, one can dynamically locate and catalog water impoundments of whatever size selected. Furthermore, map overlays may be produced from the same data source. Water distribution overlays produced in this manner serve to show the location of "new" water bodies that do not appear on maps and water bodies that appear on maps but no longer exist.

Techniques used to produce the water distribution map overlays and the suspended material distribution maps rely only on the spectral sensitivity of the scanner and the spatial integrity of the data. For many applications this is sufficient. However, the increased awareness and concern for the environment and the ever-increasing need to monitor the impact of man's activities on the environment have resulted in the need to observe and monitor changes of time. This demonstration showed how the size of an area inundated were computed and displayed as a result of a specific stage change on the Mississippi River during flood as time went on. Examples of other time dependent terrain surface phenonemon that have been observed and analyzed are bank and levee erosion along the Mississippi River to establish the need for placing protective structures. The accretion and depletion of suspended material

to estimate the location and buildup rate of bars and shoals, and observation of the growth and transportation of noxious aquatic plants.

COMPUTER GRAPHICS COLLOQUIM 1-3 AUG 78

Good Morning, my name is Leonard Manson and I am in the Engineering Division in New Orleans District. The New Orleans District is located in New Orleans, and is one of the four districts in the Lower Mississippi Valley Division (LMVD) and is exclusively engaged in Civil Works Programs.

The initial effort in developing technical programs began in NOD in the early 60's and it wasn't until late in 1967 when we obtained an off-line Cal-Comp 663 Plotter, that graphics had its start.

This slide presentation will cover some of the graphic applications currently used in the New Orleans District. I would like to keep the session as informal as possible, if anyone has any questions on any application, please do not hesitate to stop me, and we will discuss the application.

The General Type Boring Log was one of the first graphics programs written in NOD. The original program logic was developed and coded for the GE 225 (8K) computer during the period Feb-May 1968. The soil symbols were written to conform to the Unified Soil Classification System. These slides show the various ways the logs can be plotted such as several rows of Borrow Borings. Mr. Walter Miller of Vicksbury District has revised and improved the program and had added additional symbols for the water table, liquid limit, and plastic limit. The number for the revised program is 741-F3-A4-230.

The general type log plot was so successful that work to produce the final report plate for the Undisturbed log was started immediately. The options were made available to show two or three semilog cycle for consolidation as shown.

All Boring Logs in the NOD for the past 9 years have been plotted using the two programs. Any district not currently using a Boring Log plot application should consider the application.

In the past few years, computer technology has made many major advances, which help the programmer in developing software to produce a completed report quality plot. In NOD, we are attempting to utilize the advantages of the Interactive display terminals, with those of the off-line plotter to allow the Engineer to develop his design, produce various intermediate work plots, and his final report plots.

Since the Stability Analysis by the Wedge Method is used daily in NOD, we'll use it as example to demonstrate how we are attempting this task. The program is run on the WES computer with a Tektronix 4014 CRT produced on a Calcomp 1036 plotter with the 925 controller. The expanded print out files are listed on the COPE 1200.

STABILITY ANALYSIS CONSIDERING UPLIFT BY THE WEDGE METHOD #741-F3-A2-530

The program is intended to have general application in providing the safety analysis of any natural or man-made earth slope embankment for which shear failure may occur along a surface approximated by a series of planes. The program is directly applicable to all cases for which the wedge method of stability analysis is valid.

SLOPE STABILITY ANALYSIS PLOT #741-F3-A2-17B

The program plots a final plate which contains a levee or embankment cross section, the soil stratification, the active and passive wedges analyzed, and soil properties of each stratum. A tabular listing of the wedges that are analyzed and their corresponding driving forces, resisting forces, summations of forces and factors of safety, a title block, definitions of the symbols that are used, and variable general notes are also plotted.

PREREVETMENT PLOT (USED AS A TOOL FOR DESIGNING REVETMENTS) #732-F3-A2-19G

*User inputs first and last cross-section codes. Program extracts requiste data from master file.

*Program plots up to 5 years of data (latest survey in heavy black solid line). Plot used for designing and planning revetment maintenance.

*Program puts as many cross-sections on a frame as possible.

*initiated from timesharing-Calcomp plot.

CANPLOT #741-F3-A2-020

Canplot is a program which enhances the Canwall program by the addition of an on-line plotting capability which can produce temporary design plots on the Tektronics CRT and report-ready plots on the Calcomp plotter.

PIEZOMETER PLOTS #713-F3-A2-17

Gives a graphical representation over a three-month period of the following: Water elevation in piezometer, the percent of differential head that the water elevation in piezometer experiences with repect to differential head, the tail water elevation, and head water elevation. These plots are of the piezometers located in the Old River Control Structure.

PIEZOMETER INFORMATION SYSTEM PLOT (CRT VERSION) #732-F3-A2-20F

Plots same information as Calcomp version, with enlarged labeling for CRT legibility. (Calcomp version: 732-F3-A2-20D)

PIEZOMETER PLOT PROGRAM #732-F3-A2-20D

This program plots the data output from the extract program (#732-F3-A2-20C).

PROFILE PLOT #732-F3-A2-420

The program can plot a maximum of six different profiles with any combination of the following options; plotting to any horizontal and vertical scale, plotting the horizontal and vertical staffs at various intervals, calculating the intersections of specific profiles with each other, computing the total area and distance that any profile falls below another, plotting sets of notes, (3 characters or 36 characters) by any profile point, plotting equation stations in either a continuous or discontinuous manner, plotting a profile legend, and plotting descriptive notes along any reach or reaches of the profile.

ELEMENT SURVEY PLOT (CALCOMP VERSION) # 722-F3-A2-060

The program can calculate the area under any or all of six flow lines and the element range. Any number of element ranges may be overlayed on the plot to show the variation of the ranges over a number of years. The program is unlimited in respect to the number of points per section and the number of sections per run.

ELEMENT SURVEY PLOT (CRT VERSION) #722-F3-A2-380

The program plots Standard Hydro Element Ranges over the CRT terminal and allows the user to change any number of points on the current element range. The user also has the option of updating flowline and or slope data. This updated data is then used to create a new master tape. The program is unlimited in respect to the number of points per section and the number of sections per run.

OLD RIVER BOOM SURVEY PLOT (CRT VERSION) #713-F3-A2-18A

The program plots Boom Survey Data over CRT terminal from either an existing master file or from raw data input. The user also has the option of overlaying up to 13 sections to any scale desired, and making an unlimited number of plotted frames in a run. Sections plotted from a master file are extracted by hold distance, date of survey and time of survey.

OLD RIVER BOOM SURVEY PLOT (CALCOMP VERSION) #713-F3-A2-18B

The program extracts Boom Survey Data from existing master files according to the hold, date and time parameters inputed. The program can also overlay up to 13 sections to any scale desired, and plot an unlimited number of frames per run. Instead of plotting, the user has the option of creating a file with the extracted sections. This file can be listed, changed, if needed, and plotted in a later run.

OLD RIVER CONTROL STRUCTURE TAILBAY LEADLINE CALCOMP/CRT PLOT #733-F3-A2-13C & 13D

Survey data is reduced and stored. Data is extracted and plotted per the user's request. Window option is available-CRT and, Calcomp options available.

HYDRO RANGE ADJUSTMENT WRT ANOTHER BASELINE #733-F3-A2-360

For each range, the program determines the distance and direction along the range azimuth from the original baseline to a new baseline and determines the station at which the range intersects the new baseline. It can also make the necessary adjustments to the "A01" and "B" record data from the "Cross Section Survey System" and thereby generate a new master tape referenced to the new baseline. The program will also plot a plan, if required, which consists of the original and new baselines and the ranges, all of which are within a predefined plate window.

RANGE PLAN PLOT #723-F3-A2-090

The program will plot in record map form either a baseline, or a Hydro Survey layout of typical "Atchafalaya Bay" plan, or a range plan showing either one or two surveys with or without rip rap and concrete mattress notation and appropriate lettering.

REVETMENT RANGE ADJUSTMENT WRT ANOTHER BASELINE #733-F3-A2-270

For each revetment range from either the "Prerevetment Plotting System" or the "Revetment Maintenance System", the program determines the distance and direction along the range azimuth from the original baseline to a new baseline and determines the station and the latitude and longitude at which the range intersects the new baseline. It then generates range output in the format of the "Cross Section Survey System" data base which is referenced to the new baseline. the program will also plot a plan which is a polyconic X, Y projection and which consists of the original and new baselines and the ranges, all of which are within a predefined plate window.

REVETMENT PLAN PLOT (I.D. NO. 6K25001) #732-F3-A2-270

The program establishes a plot depicting the structure azimuth lines (SAL) for revetments, the ties of these profile lines to a traverse, the traverse, the revetment ranges including elevations along them, and pertinent labeling and tabulated listings. It also determines the SAL curve data and SAL profiles.

GENERAL INFORMATION PLOT #733-F3-A2-250

This program generates a record map showing the positions of borings, bench marks, utilities, or baselines and/or a respective waterway or levee centerline which can be sent remote batch from a HIS G-635 to a Calcomp Drum Plotter, model 925/1036. It is also part of the "Data Bank System".

MINIMUM CHANNEL ALIGNMENT AND PLOT #732-F3-A2-260

Option 1: Given a channel cross section and a template the program determines that template position at which the cut area between the cross section and template is a minimum. Option 2: Using the output from the centerline analysis program, calculates the intersections of the cross sections with the aligned channel centerlines and calculates its area at the intersected location. It then approximates the area for each new aligned centerline station and calculates the quantities of cut between the aligned centerline stations. The cross sections with the design template superimposed on it is then plotted and the spoil area required, in acres, is calculated between the channel orcenterline stations.

CROSS SECTION VOLUMES AND PLOT #732-F3-A2-130

Given a reach of cross-sections and as many as three templates per cross-section, the program calculates the areas of cut and fill between them. The program then calculates the individual and accumulated quantities of cut and fill between the cross-sections considering corrected distances along curves and P.I.'s. The program then plots the cross-sections with its templates superimposed on them. The areas and volumes of overdepth for channel cross-sections are also calculated if specified.

COMPARATIVE SECTION PLOT #732-F3-A2-160

The program creates and maintains a master tape, by job title, of scour survey cross sections. It then extracts the cross sections desired to be plotted and determines the number that can be plotted on each plate. It then plots each plate with the following options: Any horizontal and vertical scale, length of plate in multiples of 8 inches, any width, horizontal staff at various intervals, plotting sets of notes (3 characters or 36 characters) by any cross section point, and plotting a legend and title block.

TOPO AND HYDRO SURVEY PLOT #723-F3-A2-050

The program plots Topo and Hydro Surveys, inputted in NOD standard "A, B or C" format as cross sections in profile and to any horizontal and vertical scale. The program is unlimited with respect to the number of points per section and the number of sections per run.

AZIMUTHAL EQUIDISTANT PROJECTION # None Assigned (Subroutine)

To graphically display the world or parts thereof based on the Postel or Azimuthal Equidistant Projection or any other Azimuthal Projection such as Azimuthal Equivalent, Orthographic, Stereographic or Gnomonic from an arbitrary origin. Two data files are available,one containing the outline of the world's continents, etc., and the other a finer detail on the Carribean from N. Carolina to the Amazon. A variable spacing geodetic grid is added.

STRUDL PLOTS #713-F3-A2-999

Examples of plots produced by McAuto "FAS2" graphics routine:

a. Plots structures in their original and/or deflected shapes.
b. Plots structure member and elements, annotated.
c. Plots the different orientations of structure.
d. Plots segments of structures.
e. Plots stress patterns experienced for each loading condition.

OPTIMIZATION OF OPENING ANGULAR VELOCITIES OF A PAIR OF SECTOR GATES: DESIGN PLOTS #722-F3-A2-270

This is a series of plots containing various variables calculated from the program which computes the composite of four uniform speeds of sector gate operations such that at no time is a design turbulence limitation (input by user) exceeded. The four speeds are derived from three head conditions and the optimum machine limitations for opening the pair of sector gates.

DISCHARGE RATING CURVE PLOT #722-F3-A2-48H

To compute and plot for any station in NOD,an annual rating curve, based on the Historical Data available, (Calcomp plot).

CONTROLLED DISCHARGE RATING CURVES PLOT (AND LIST) FOR TAINTER-GATED DAMS #722-F3-A2-200

To calculate, list and/or plot discharge values versus tailwater elevation for various gate openings. Variables input by user: upper pool(s), tailwater range and increment in ft., gate width, gate opening(s) range and increment, sill elevation, Dam ID and date.

HEIS MEAN-MAX-MIN PLOT #723-F3-A2-12B

To plot, for any Heis parameter at any location in NOD, for any period of record the user desires, the mean, maximum and minimum values that are statistically derived from the extracted data.

STAGE HYDROGRAPH PLOT #722-F3-A2-020

Plots stage vs. the date of occurence for a station for a given year. All data is extracted from master files by user request.

STAGE-CHANCE PLOT #722-F3-A2-33H

For N-years of data (extracted from master files by user), this program ranks the data for a given day of the year and plots the max, 10%, 30%, 50%, 70%, 90% and min values. These are interpreted to imply the stage such that the records show N% of the data equaled or exceeded that stage.

HEIS DURATION PLOTS (HYDROLOGIC ENVIRONMENTAL INFORMATION SYSTEM) #722-F3-A2-080

A. Description of graph

1. The ordinate axis has a variable scale automatically computed by the program and represents the parameter values, usually in parts per million.

2. The abscissa axis is annotated to a scale proportional to the area under normal distribution.

B. The values plotted represent the percentage of the time a particular selected parameter value is exceeded or equaled from a group of data.

C. Selection of data

1. User first selects the station he is interested in seeing the data plotted for.

2. The user then has the option to select one of four periods:

a. Annual
b. Multiple years
c. Individual months for any number of years
d. Seasonal--four groups of three months.

HIGH WATER PROFILE PLOT #722-F3-A2-040

The program optionally plots the stream invert profile, the right and left bank profile and maximum of six high water profiles for any stream.

HYDROLOGIC ENVIRONMENTAL INFORMATION PLOT #723-F3-A2-03H

Plots water quality parameters for specified locations against a calendar scale in the X-direction and magnitude of measurement in the Y. The Y- scale is a function of the parameter code and may be cartesian or any number cycled log. Additionally, microfilm plotting is available through the WES Calcomp CRT.

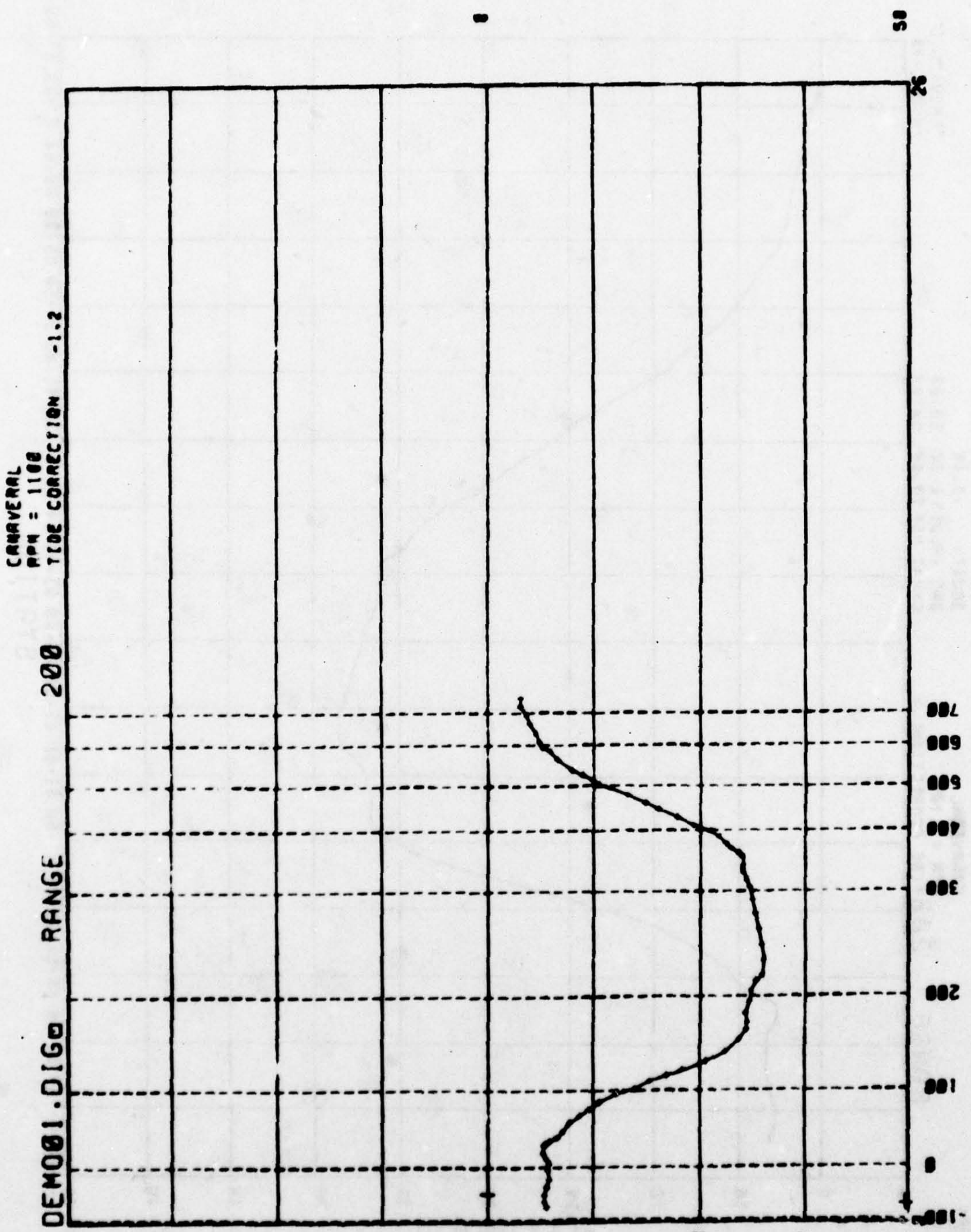
HEIS SALINITY PLOT #722-F3-A2-110

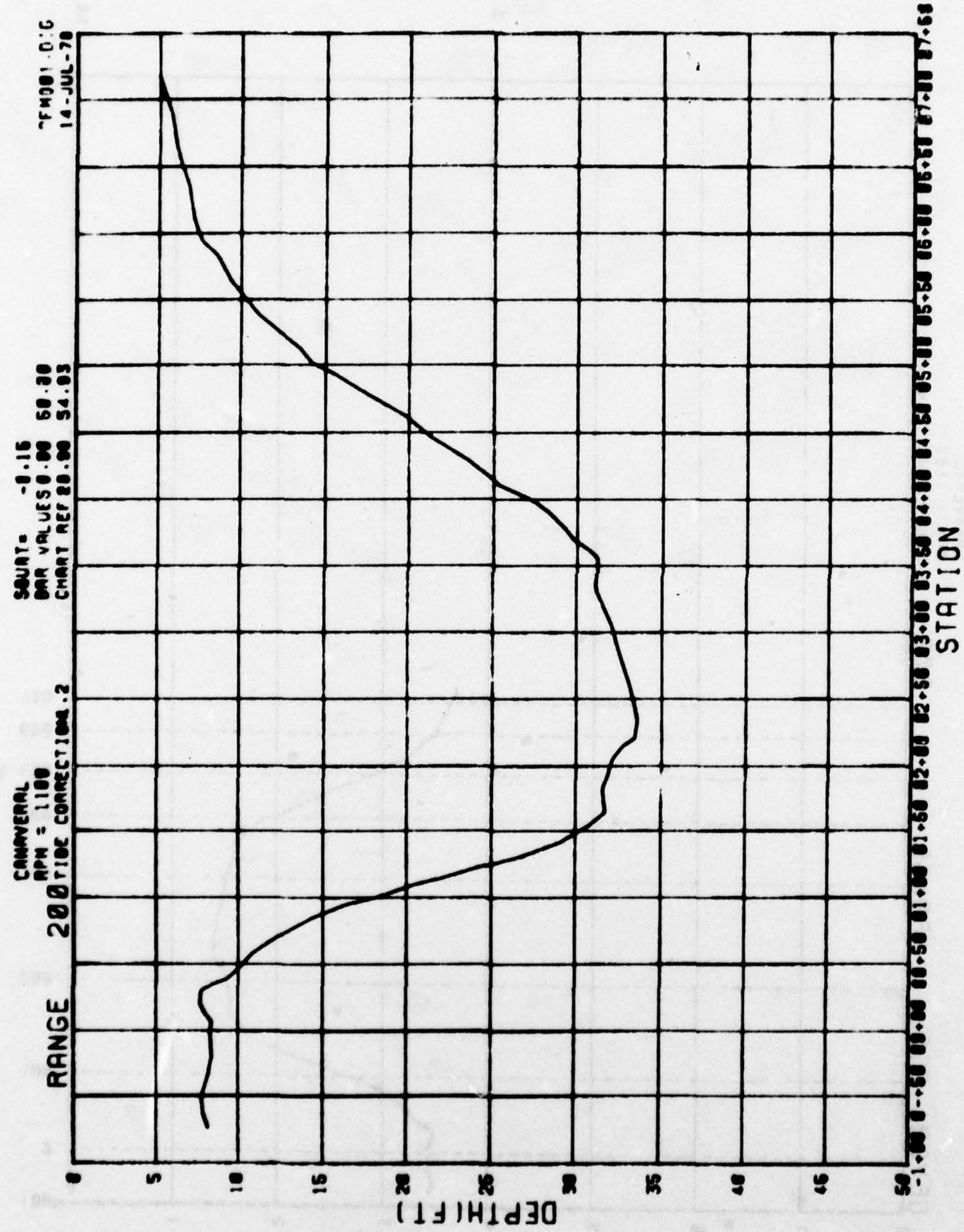
To plot salinity vs. date of occurrence for a station for a given year. Input: cards containing dates and salinity readings.

STAGE-RELATIONSHIP; PLOT, AND/OR LIST PROGRAMS #722-F3-A2-33J

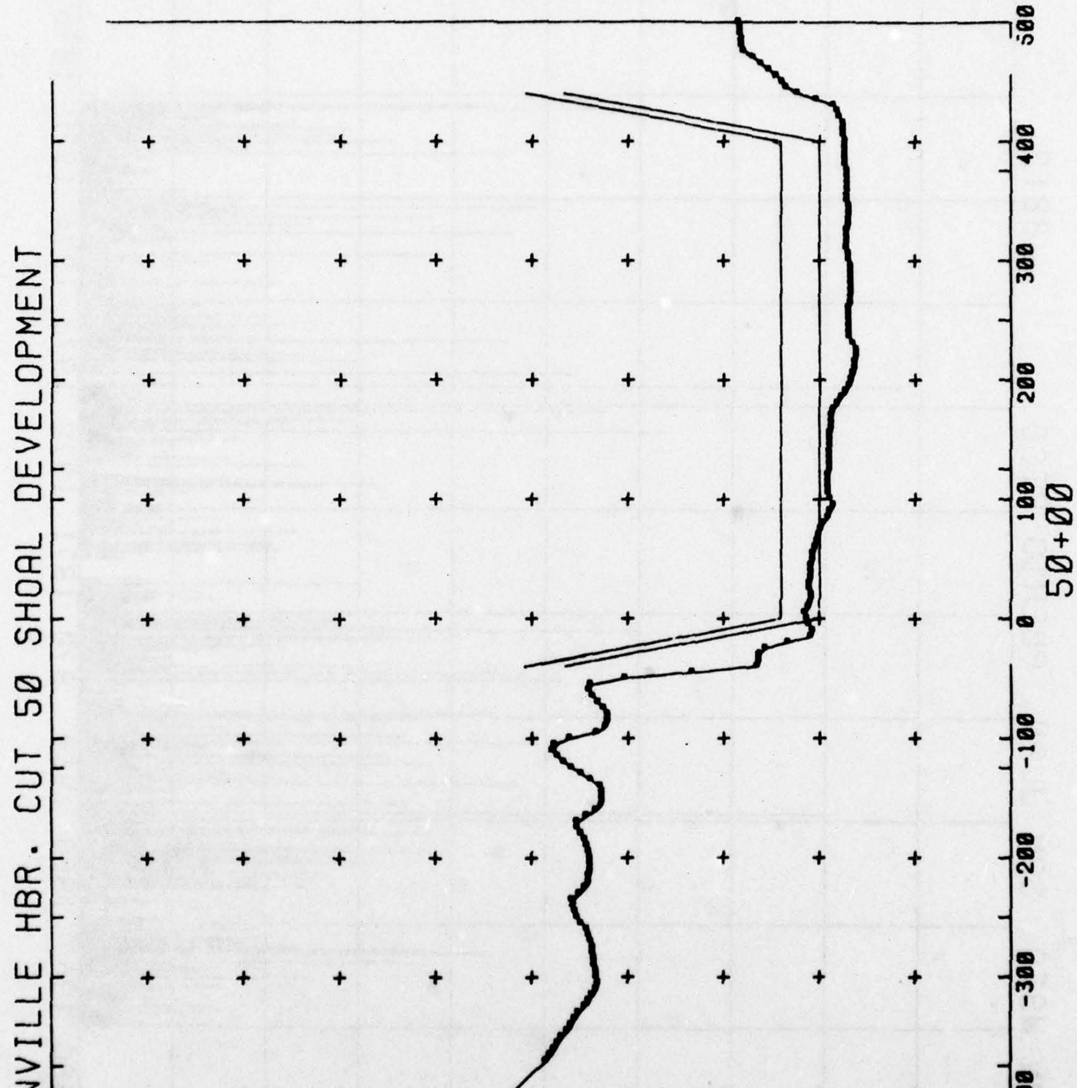
The program extracts and utilizes data from the stage master and discharge masters to plot the coordinate data. This data is then used as input to WES library program, Polfit, which determines a 7th degree polynomial by least squares technique. The 7th degree polynomial is then used to draw the curve thru the maximum and minimum range of data points.

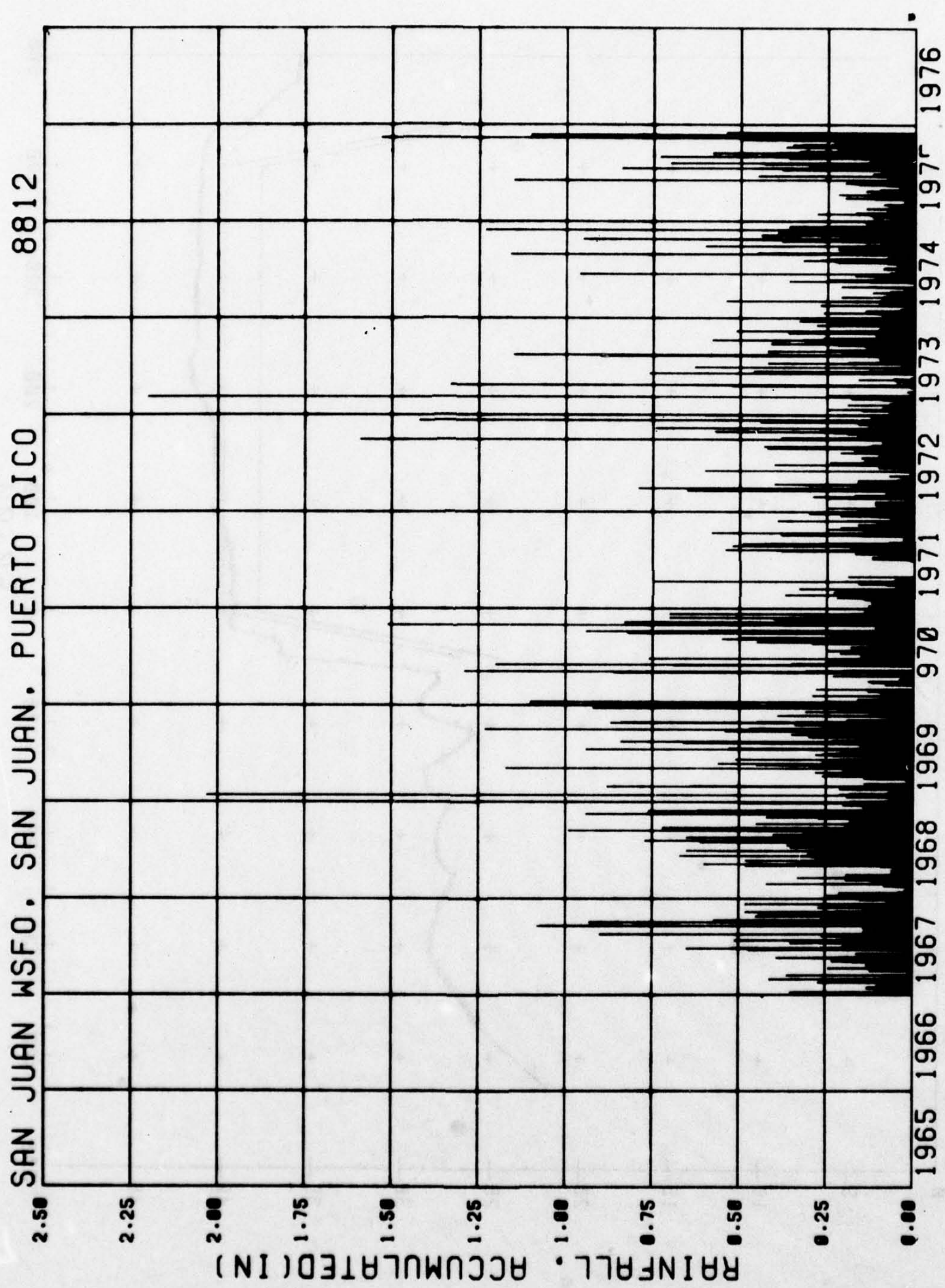
THESE ARE COPIES OF A SERIES OF PROGRAMS DEVELOPED BY JACKSONVILLE DISTRICT AND PRESENTED BY OSCAR KNAPPE


DEMOØ1.DIGØ RANGE 200
CANAVERAL
RPM = 1100
TIDE CORRECTION -1.2
-100
0
100
200
300
400
500
600
700
1
2
3
4
5
6
7
8

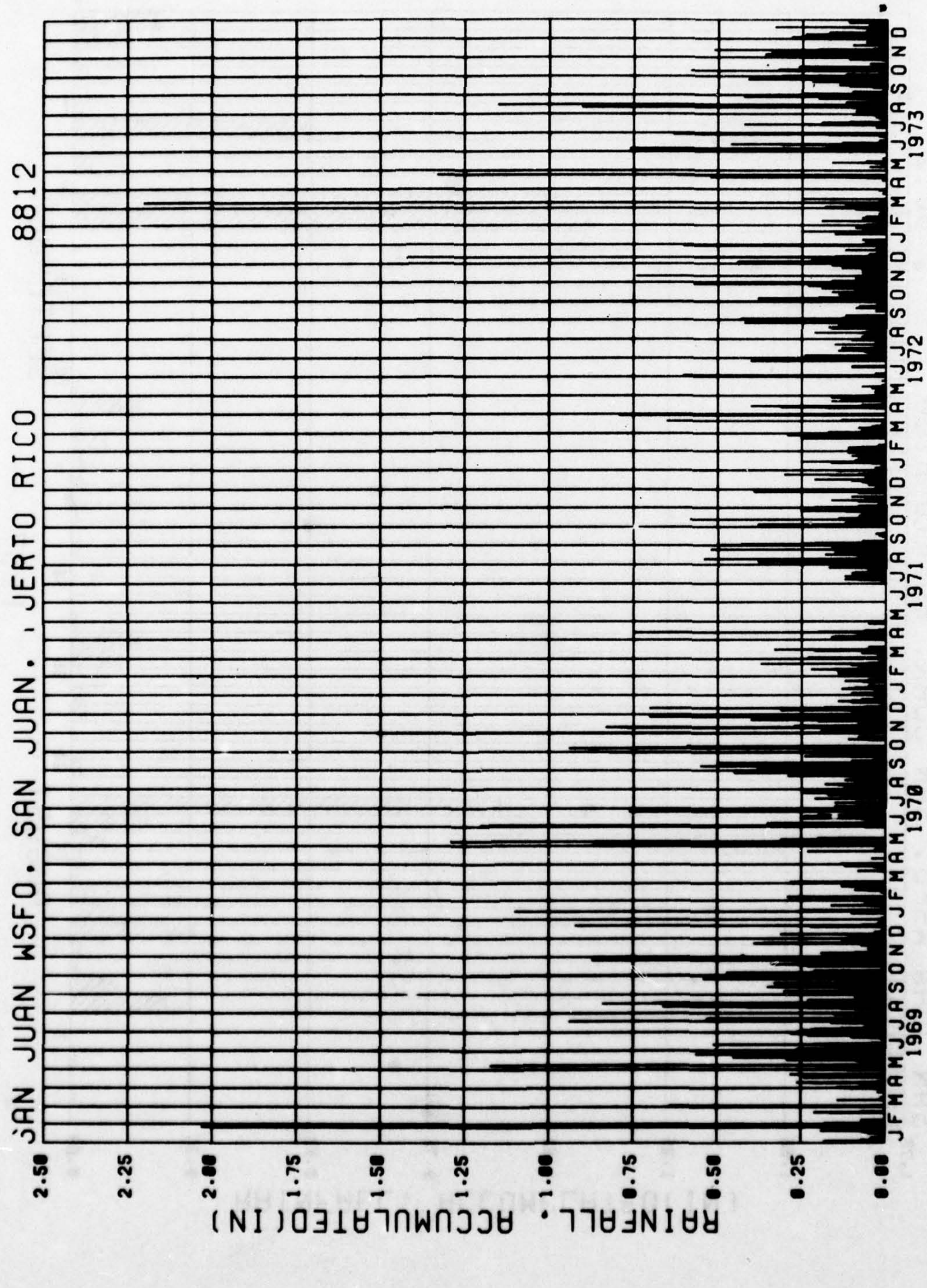


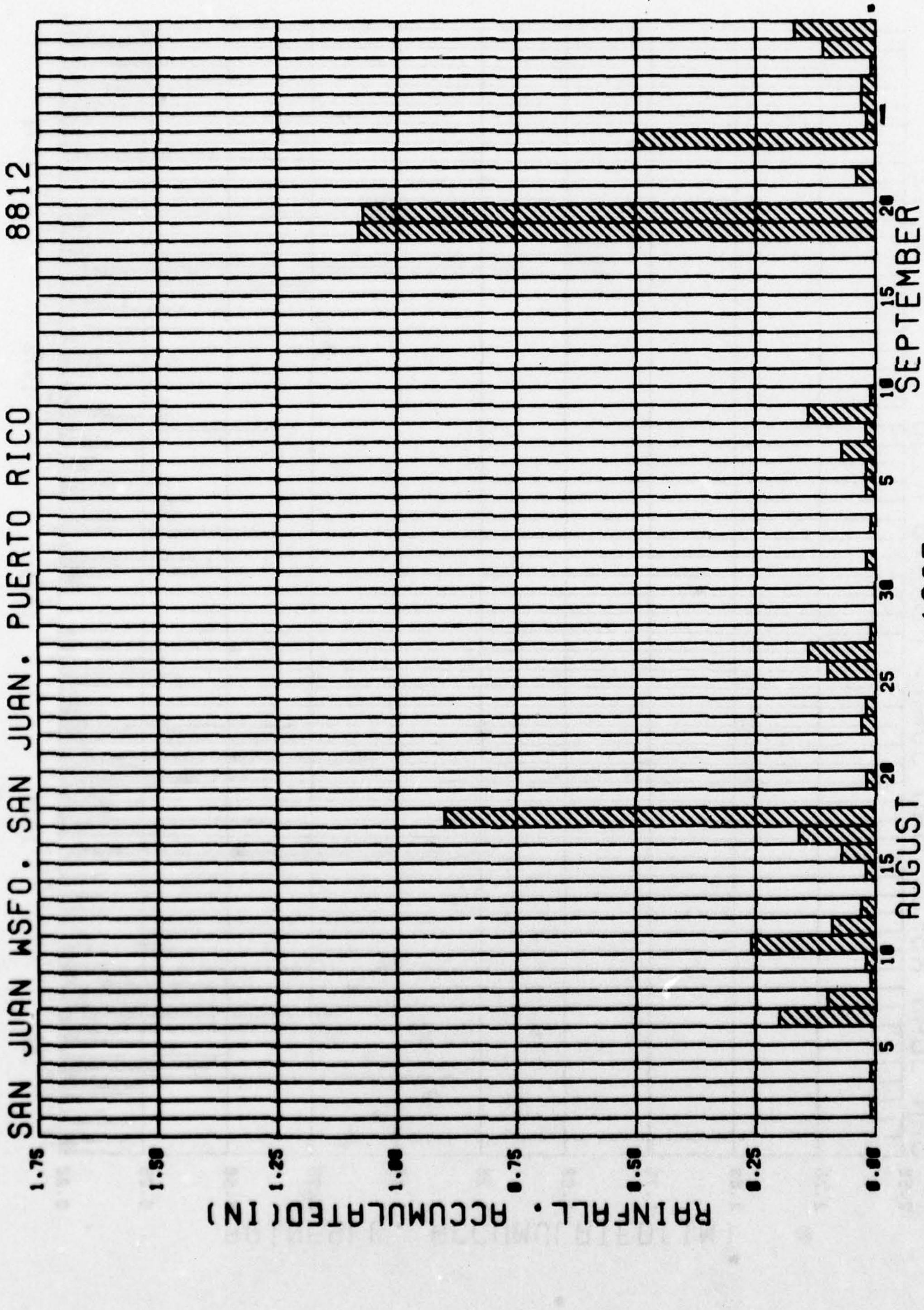
RANGE 200
CANAVERAL
RPM = 1100
TIDE CORRECTION .2
SQUAT= -0.15
BAR VALUES 0.00 50.00
CHART REF 20.00 54.03
14-JUL-78
0
5
10
15
20
25
30
35
40
45
50
DEPTH(FT)
STATION

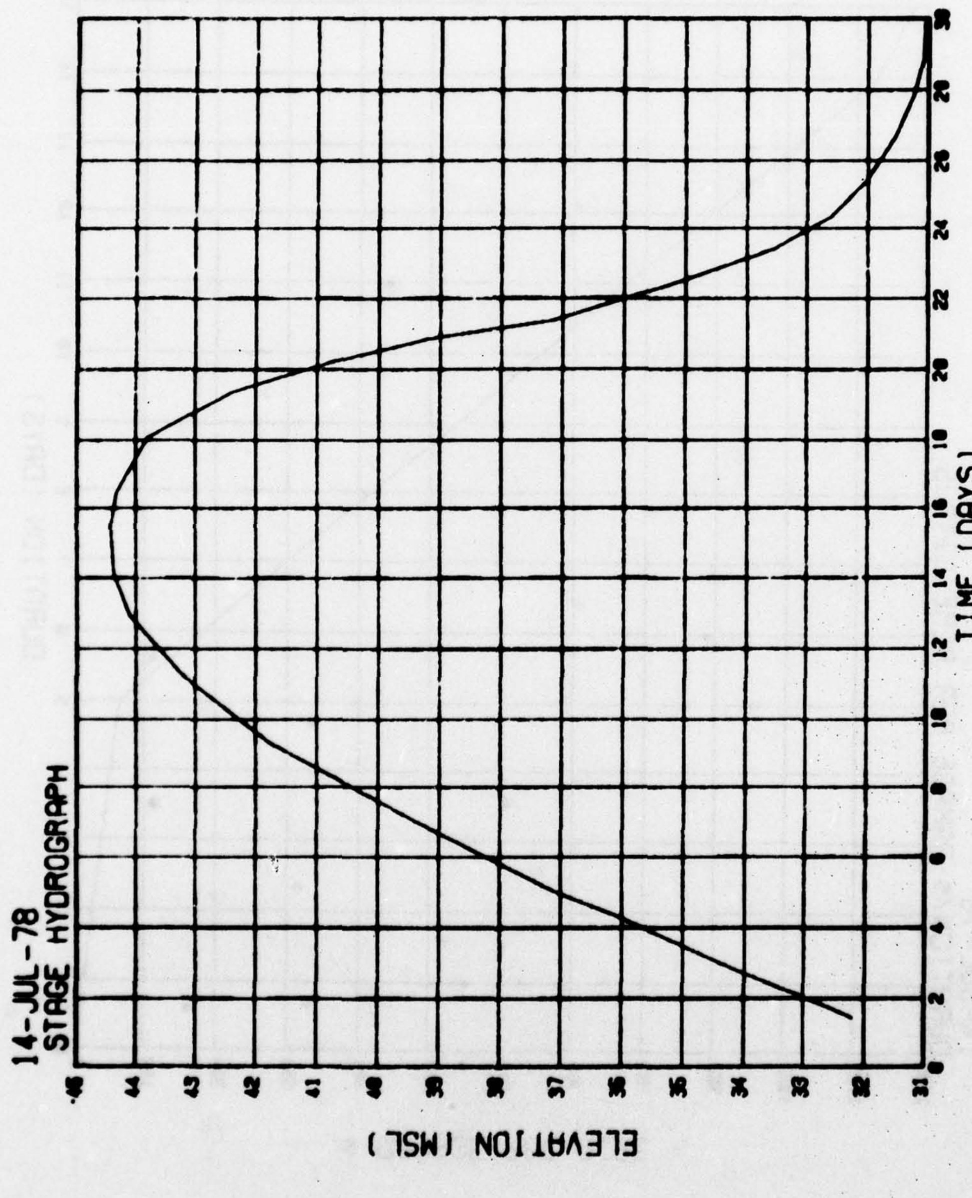

JAXSONVILLE HBR. CUT 5Ø SHOAL DEVELOPMENT
0
5
10
15
20
25
30
35
40
45
500
-400
-300
-200
-100
0
100
200
300
400
500
5Ø+ØØ



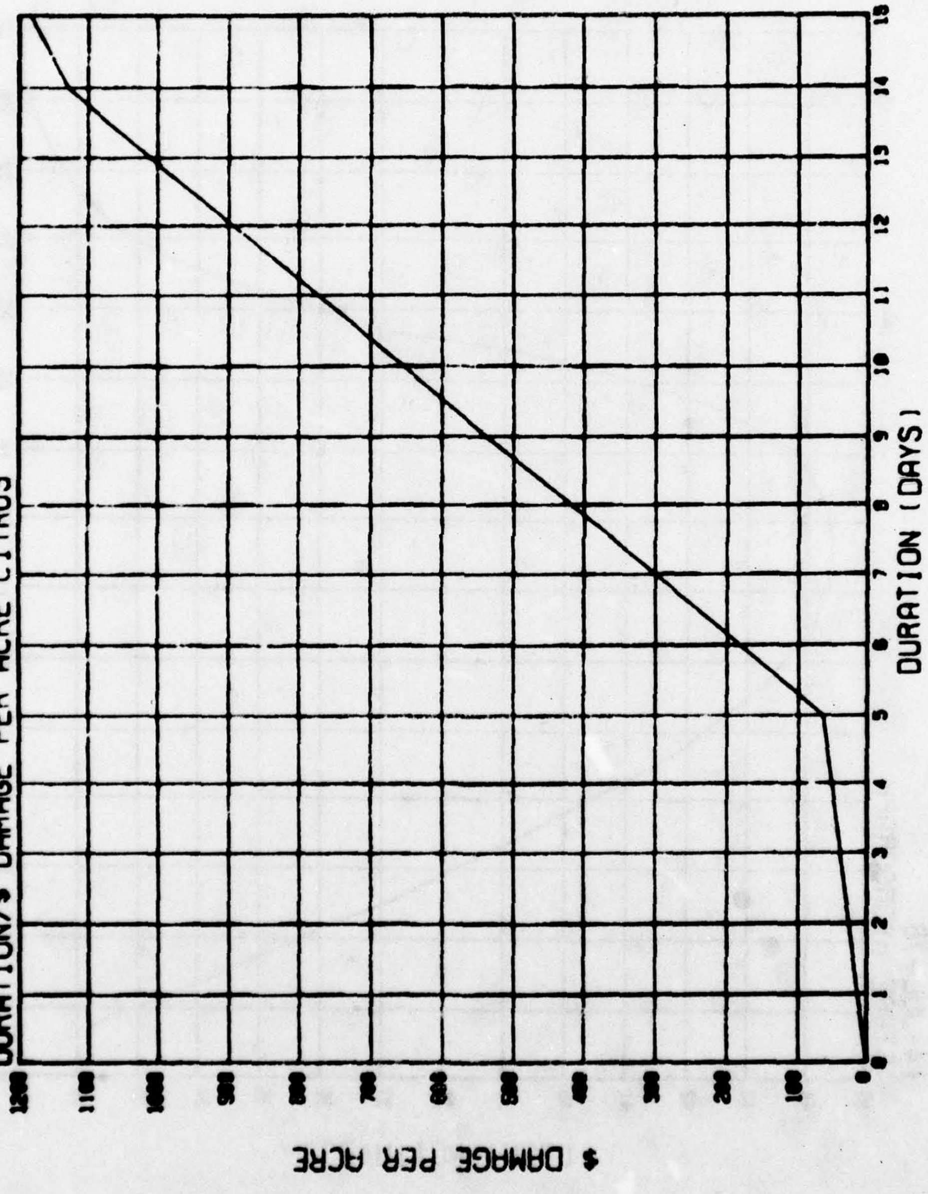
SAN JUAN WSFO. SAN JUAN. PUERTO RICO 8812
RAINFALL. ACCUMULATED(IN)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976

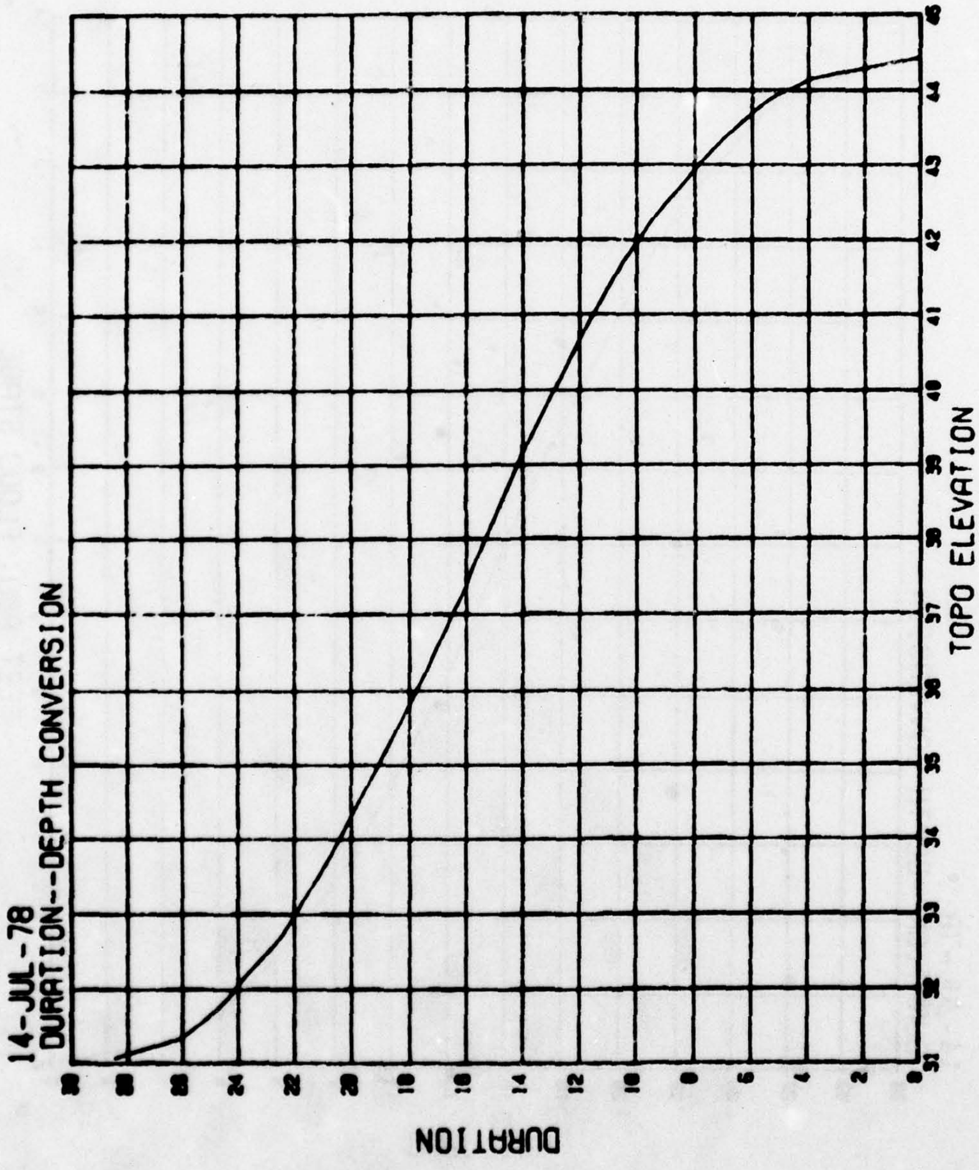

SAN JUAN WSFO. SAN JUAN. ,JERTO RICO
8812
RAINFALL, ACCUMULATED(IN)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1969
1970
1971
1972
1973

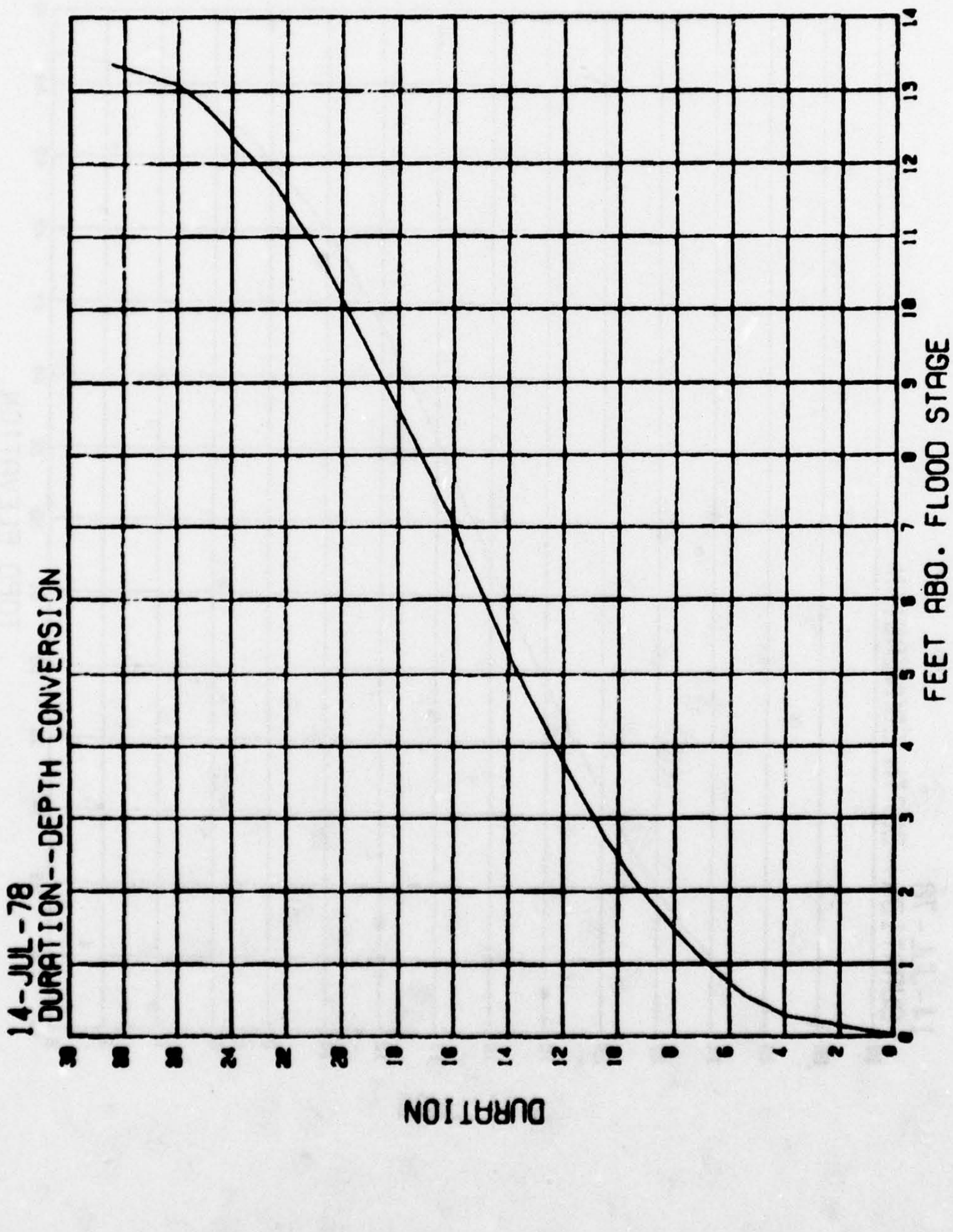

SAN JUAN WSFO. SAN JUAN. PUERTO RICO
8812
RAINFALL, ACCUMULATED(IN)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
5
10
15
20
25
30
5
10
15
20
AUGUST
SEPTEMBER
1967

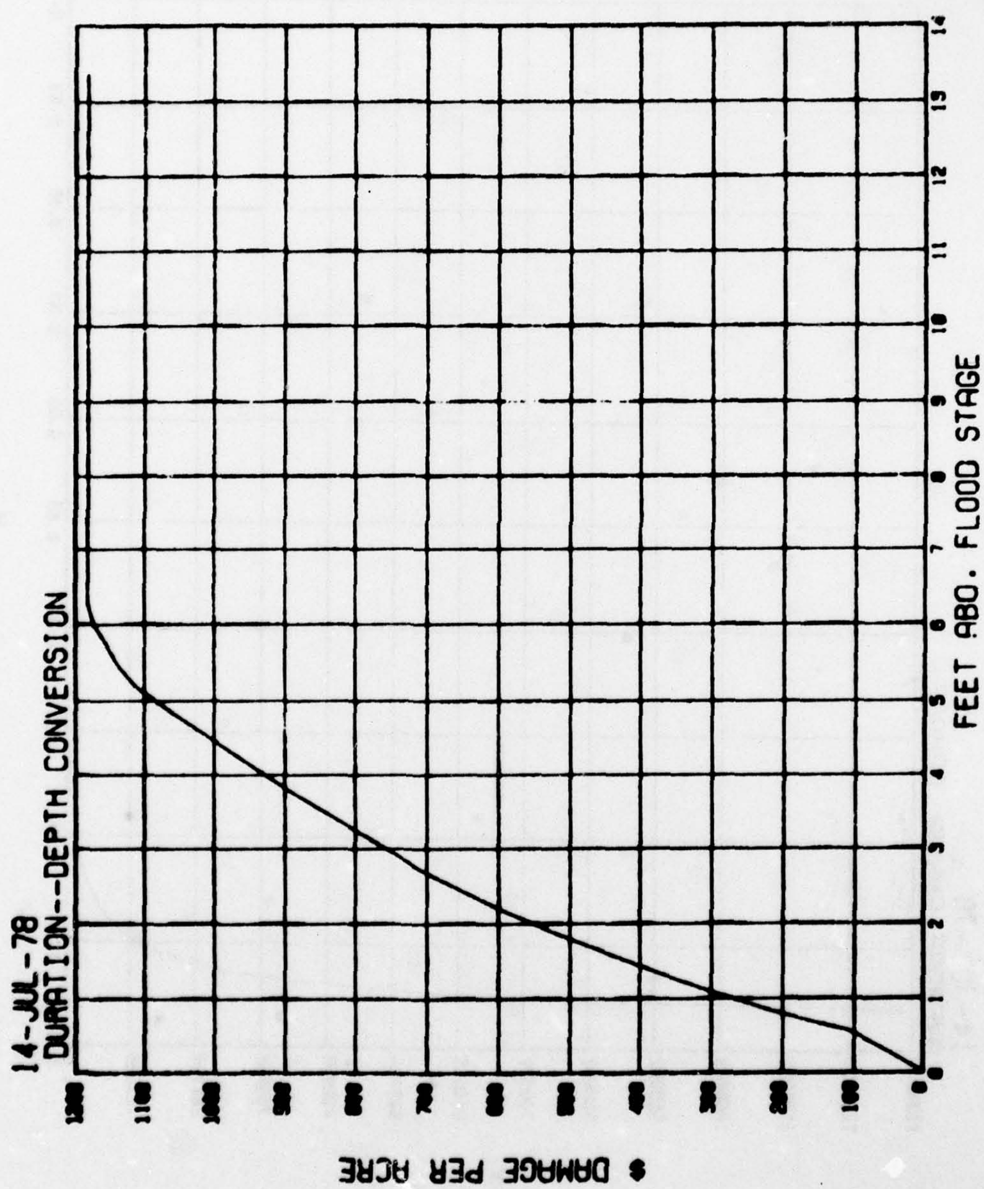

14-JUL-78
STAGE HYDROGRAPH
ELEVATION (MSL)
TIME (DAYS)

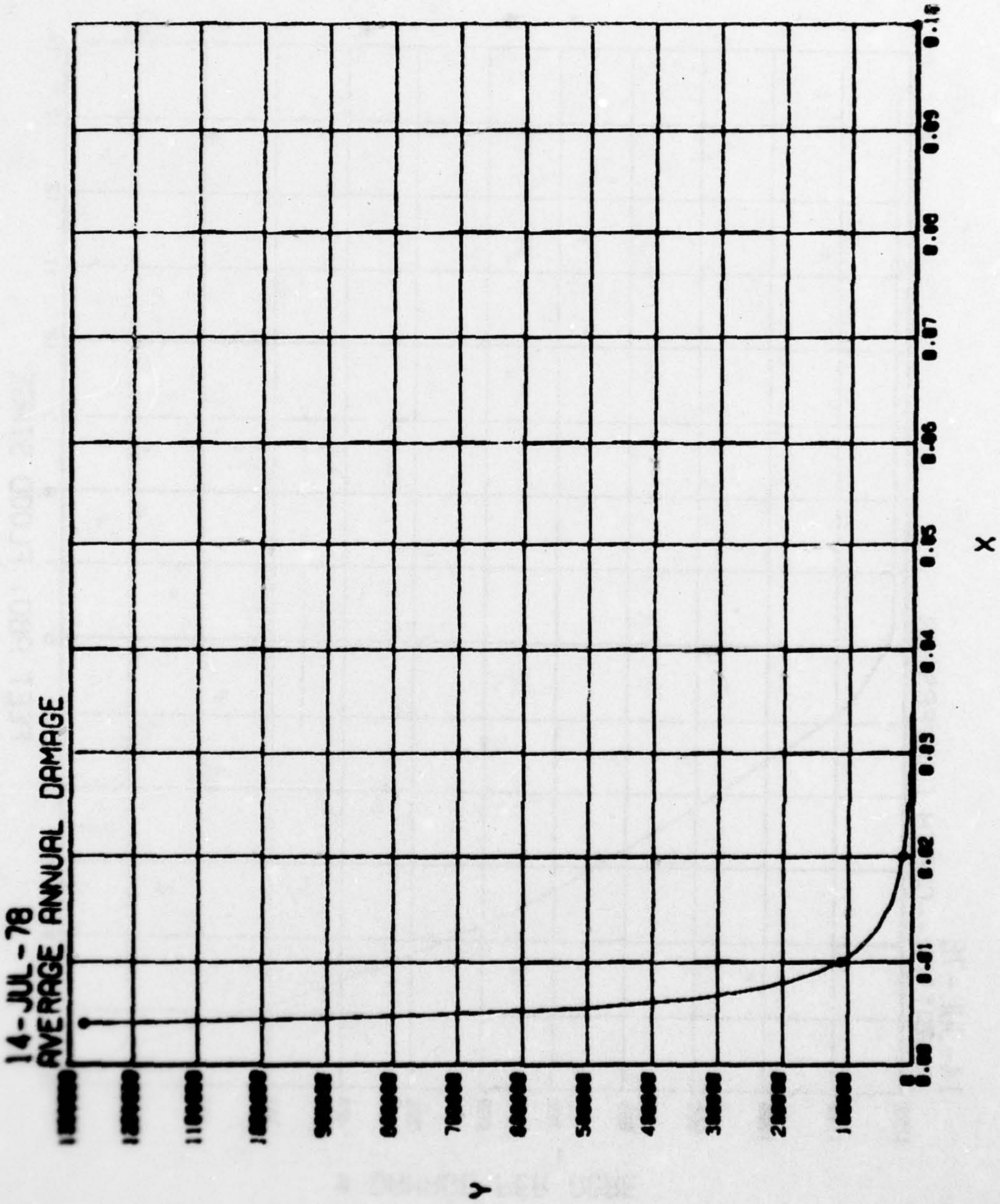
14-JUL-78
DURATION/$ DAMAGE PER ACRE CITRUS

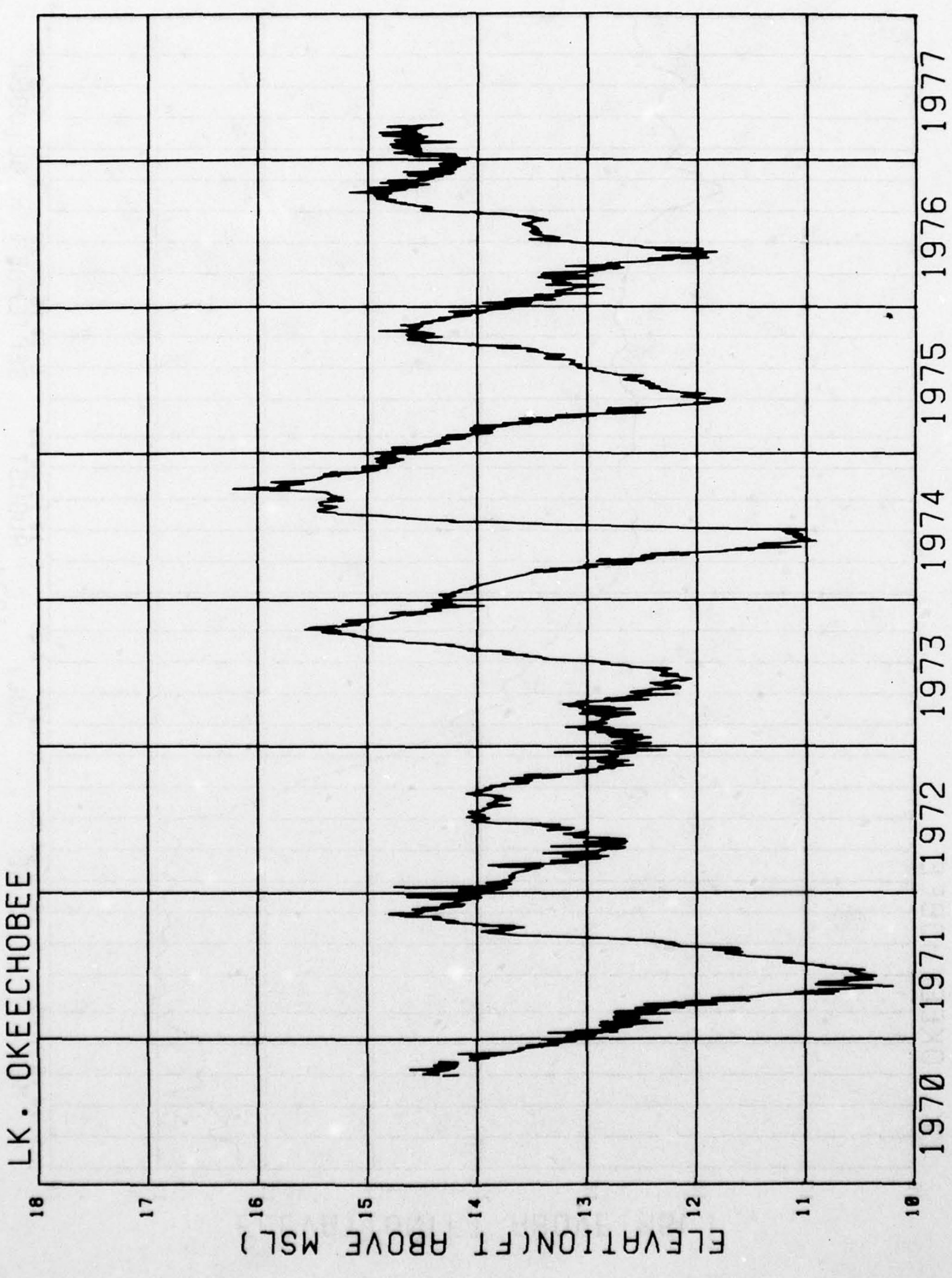


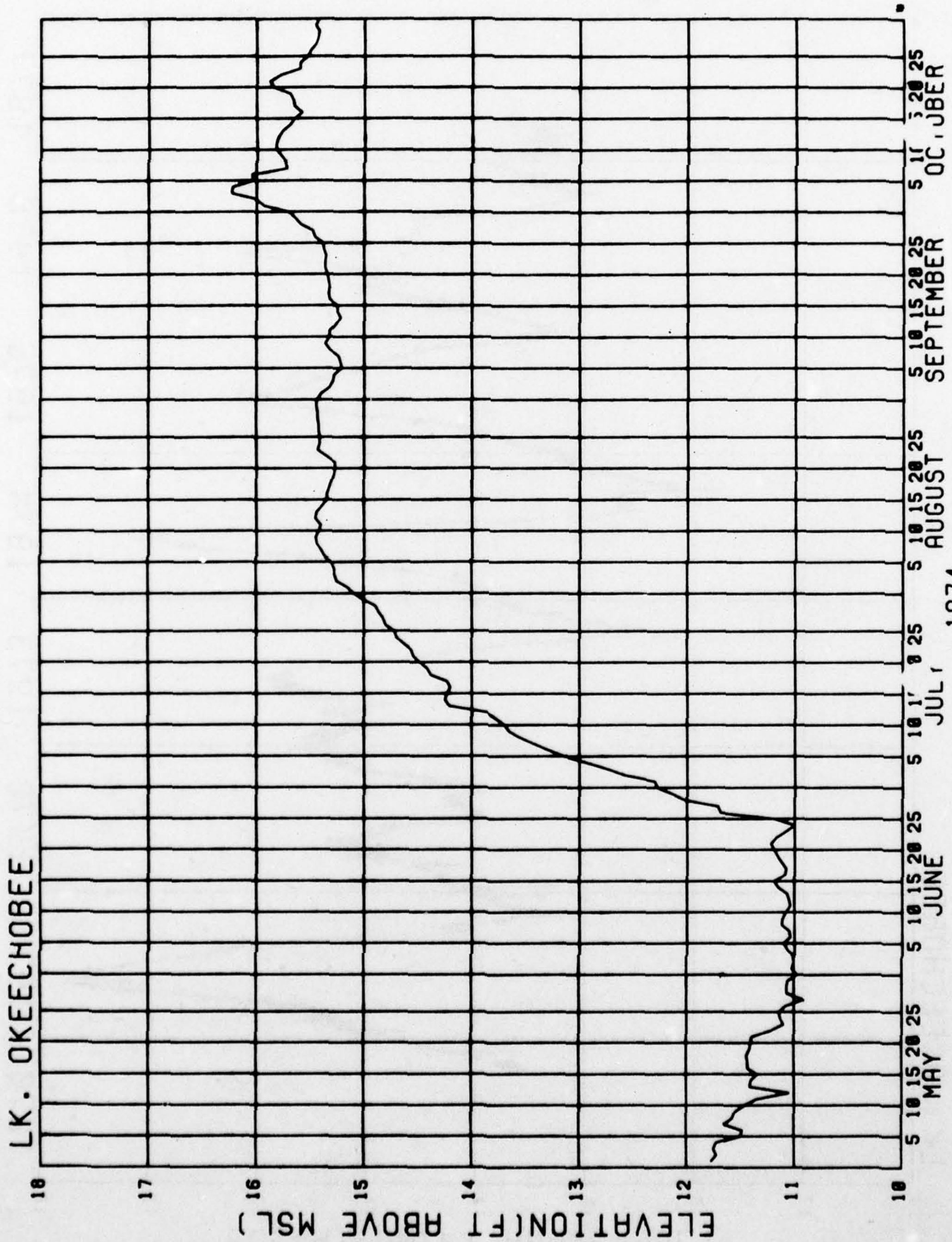

14-JUL-78
DURATION--DEPTH CONVERSION
TOPO ELEVATION
DURATION


14-JUL-78
DURATION--DEPTH CONVERSION
FEET ABO. FLOOD STAGE
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
DURATION
0 2 4 6 8 10 12 14 16 18


14-JUL-78
DURATION--DEPTH CONVERSION
FEET ABO. FLOOD STAGE
$ DAMAGE PER ACRE


14-JUL-78
AVERAGE ANNUAL DAMAGE
X
Y


LK. OKEECHOBEE
ELEVATION(FT ABOVE MSL)
18
17
16
15
14
13
12
11
10
1970
1971
1972
1973
1974
1975
1976
1977


LK. OKEECHOBEE
ELEVATION(FT ABOVE MSL)
18
17
16
15
14
13
12
11
10
5 10 15 20 25
MAY
5 10 15 20 25
JUNE
5 10 15 20 25
JULY
5 10 15 20 25
AUGUST
5 10 15 20 25
SEPTEMBER
5 10 15 20 25
OCTOBER
1974

"Tektronix 4081 Support of Expanded Flood Plain Information Studies in the Pittsburgh District"

Summary of video-taped demonstration presented at the Computer Graphics Colloquium, 1 - 3 August 1978, Waterways Experiment Station. William R. Noullet (ADP Center)
Henry A. Edwardo (FPMS Br.)

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Overview

The Pittsburgh District is currently performing one of eleven Corps-wide R&D projects involving the expansion of the traditional Flood Plain Information report. The Expanded Flood Plain Information Study for the Upper Sewickley Creek Basin in Westmoreland County, Pennsylvania, is an interdisciplinary team effort in the spatial analysis of land use changes and the impacts these changes have on hydrology,economics, and the environment. The most difficult task in the study is the creation of a grid cell data bank of physiographic information containing such parameters as existing land use,soil types and topographic detail. This data bank is then accessed by hydrologic, economic and environmental modeling programs. The Tektronix 4081 Interactive Graphics System is being used by the Pittsburgh District to digitize such information and convert it to the grid cell representation needed for subsequent computer modeling.

Hardware

The Tektronix 4081 Interactive Graphics System was installed in the Pittsburgh District in March 1978. The system components are as follows:

Display Controller: Cathode Ray Tube having both storage and refresh graphics capability.

Hard Copy Unit: Thermal copier,used in lieu of a line printer. Copies contents of display controller to 8½" x 11" paper.

Dual Flexible Disk Unit: Two "floppy" disks each of which provide 315K bytes of storage.

Graphics Tablet: 30" x 40" digitizing tablet with a resolution of 10,000 points x 7,500 points respectively or 250 points per inch.

Tape Cartridge Unit: Magnetic tape cartridge unit providing 256K bytes of storage.

Central Processor: Interdata 7/16 minicomputer with 64K bytes of memory.

Communications Interface: Asyncronous RS 232 interface; Bell 212A data set at 1200 baud.

The 4081 also provides software support for the Fortran VI programming language. Several of the programs that were run during the demonstration summarized below were taken from the Boeing Computer System and converted to run directly on the 4081.

Summary of Demonstration

Graphics Function Manager (ACOGFM): Tektronix supplied and supported software used to create picture files. ACOGFM was loaded into memory together with a "workspace" which established the tablet as the source for graphic input (GIN) and assigned the alphanumeric character set and graphic command strings to a menu area on the tablet. This menu essentially made the tablet an extension of the keyboard. Figure 1 shows the menu (which can be placed anywhere on the tablet by using the command MENUSHIFT) and Figure 2 lists the workspace (loaded as file ACOFVE.WSP).

Using ACOGFM and the workspace, reference point and land use polygon data were digitized. The procedure was as shown in Figures 3 thru 6. Figure 3 shows the type of source map being digitized. Figure 4 displays the procedure for digitizing reference points (RM,s) and inputing their identifying numbers. This data is created as a binary PDB (Picture Data Base) file named LU.PDB. Figure 5 displays the procedure for digitizing land use data via the polygon method and encoding the polygon number and land use type. For example, polygon number one on this map has land use type 08 and would be named LU0108, each polygon being created as a separate binary PDB file. Figure 6 displays the procedure for merging each polygon file into the master file LU. Figure 7 is the completed file LU.PDB which was displayed using the graphic command DISPLAY. Figure 7 and all subsequent figures were reproduced from hard copies of the display controller.

Figure 8 is a directory of the disk showing each polygon as a separate file and the master file LU. The Tektronix utility program DIRECTORY displays the contents of a disk as to filename (LU0108), file extension (.PDB), the number of consecutive 256 byte blocks of storage the file occupies ([02]), and the date and time of creation.

Picture Data Base Dump (PDBDMP): Tektronix software to display an ASCII listing of the contents of a binary PDB file. Figure 9 shows a portion of the listing for the master file LU.PDB. Figure 10 shows the complete listing for polygon file LU0108.PDB. These are presented to show that a conversion needed to be made from PDB status wherein point and line data is defined by relative moves and draws to ASCII code and a conventional coordinate system wherein all data is referenced to a common origin.

Picture Data Base Conversion (PDBCON): The Tektronix developed software to perform the above mentioned conversion. Input to the program is the binary file LU.PDB; output is an ASCII file called IPL5.ASC. Figure 11 shows the first page of the IPL5 file listing (obtained by running the utility TYPE). The 10 reference points occur first in the format X-coordinate (25.33), Y-coordinate (56.52), and ID (004), followed by a nine's record (9999). The (Y,X) pairs for each vertex of polygon number 1 occur next, four pairs per line ended by (999.99,999.99). The next line contains the (X,Y) location of the text string (0108) from the picture.

A	B	C	D	E	F	G	H	I	GO
J	K	L	M	N	O	P	Q	R	S
T	U	V	W	X	Y	Z	SPACE	.	;
0	1	2	3	4	5	6	7	8	9
CREATE	SAVE	SCALE	MOVE	ROTATE	INSTANCE	REMOVE	TEXT	REFERENCE POINT	FIX
GO	POINT	LABEL	DRAW	DASH	ERASE DISPLAY	WINDOW	VIEWPORT	RESET	DISPLAY
	ERASE	CLEAR							

FIGURE 1

```
#
#
#
#
#TYPE ACOFVE.VSP
Reset
Window   -5000  -3750   5000   3750
View -32767 -24576  32767  24575
Use Gin TB0:
Use Menu TB0:
Name Menu {A}  11756  21956  14140  23520
Name Menu {B}  14156  21972  15760  23512
Name Menu {C}  15776  21940  17364  23544
Name Menu {D}  17380  21988  18970  23544
Name Menu {E}  18984  21940  20590  23560
Name Menu {F}  20590  21956  22178  23560
Name Menu {G}  22210  21972  23814  23520
Name Menu {H}  23846  21940  25436  23576
Name Menu {I}  25468  21956  27056  23576
Name Menu {J}  11740  20350  14140  21924
Name Menu {K}  14186  20350  15776  21956
Name Menu {L}  15776  20336  17380  21972
Name Menu {M}  17380  20350  18954  21972
Name Menu {N}  18984  20336  20590  21972
Name Menu {O}  20606  20336  22210  21972
Name Menu {P}  22226  20350  23830  21924
Name Menu {Q}  23830  20336  25468  21956
Name Menu {R}  25452  20350  27056  21955
Name Menu {S}  27056  20336  28612  21940
Name Menu {T}  11756  18778  14156  20320
Name Menu {U}  14108  18730  15760  20336
Name Menu {V}  15744  18714  17380  20336
Name Menu {W}  17348  18730  18970  20350
Name Menu {X}  18954  18746  20605  20336
Name Menu {Y}  20558  18746  22194  20336
Name Menu {Z}  22178  18746  23814  20350
Name Menu { }  23798  18762  25452  20350
Name Menu {.}  25420  18778  27872  20350
Name Menu {,}  27008  18778  28628  20382
Name Menu {0}  11740  17158  14124  18714
Name Menu {1}  14108  17158  15744  18730
Name Menu {2}  15728  17158  17348  18746
Name Menu {3}  17348  17142  18938  18746
Name Menu {4}  18938  17142  20580  18762
Name Menu {5}  20574  17174  22146  18746
Name Menu {6}  22162  17174  23830  18746
Name Menu {7}  23782  17158  25420  18762
Name Menu {8}  25404  17158  27024  18762
Name Menu {9}  26976  17190  28580  18778
Name Menu {CREATE }  11708  15584  14108  17158
Name Menu {SAVE|}  14108  15568  15760  17158
Name Menu {sca}  15728  15552  17332  17174
Name Menu {tran}  17332  15568  18954  17142
Name Menu {rotate}  18938  15508  20574  17142
Name Menu {Removel}  22178  15584  23782  17174
Name Menu {|}  27040  21040  28558  23544
Name Menu {|}  14092  15522  14186  15600
Name Menu {point|}  14124  13964  15720  15584
Name Menu {line|}  17332  13996  18922  15584
Name Menu {Dash|}  18922  13980  20542  15616
Name Menu {eras;displ}  20558  13996  22162  15568
Name Menu {Window|}  22146  13996  23736  15552
Name Menu {viewport|}  23768  13980  25388  15600
Name Menu {disp }  26968  14012  28550  15616
Name Menu {TEXT|}  23782  15584  25388  17174
Name Menu {RESE; }  25372  13980  26976  15600
Name Menu {|}  11724  13980  14108  15584
Name Menu {REFPNT|}  25420  15490  27024  17078
Name Menu {ins }  20574  15552  22130  17174
Name Menu {fix|}  27040  15584  28532  17236
Define {Pnt} {2647 -1514}
Define {Refpnt} {DEFINE {PNT}XY,POINT PNT,TEXT CON(<1>) P
NT,FIX}
Name Fk1 {Era;displ}
Name Fk10 {work load acofvel}
Name Fk11 {name fk}
Name Fk12 {name menu }
#######
```

FIGURE 2

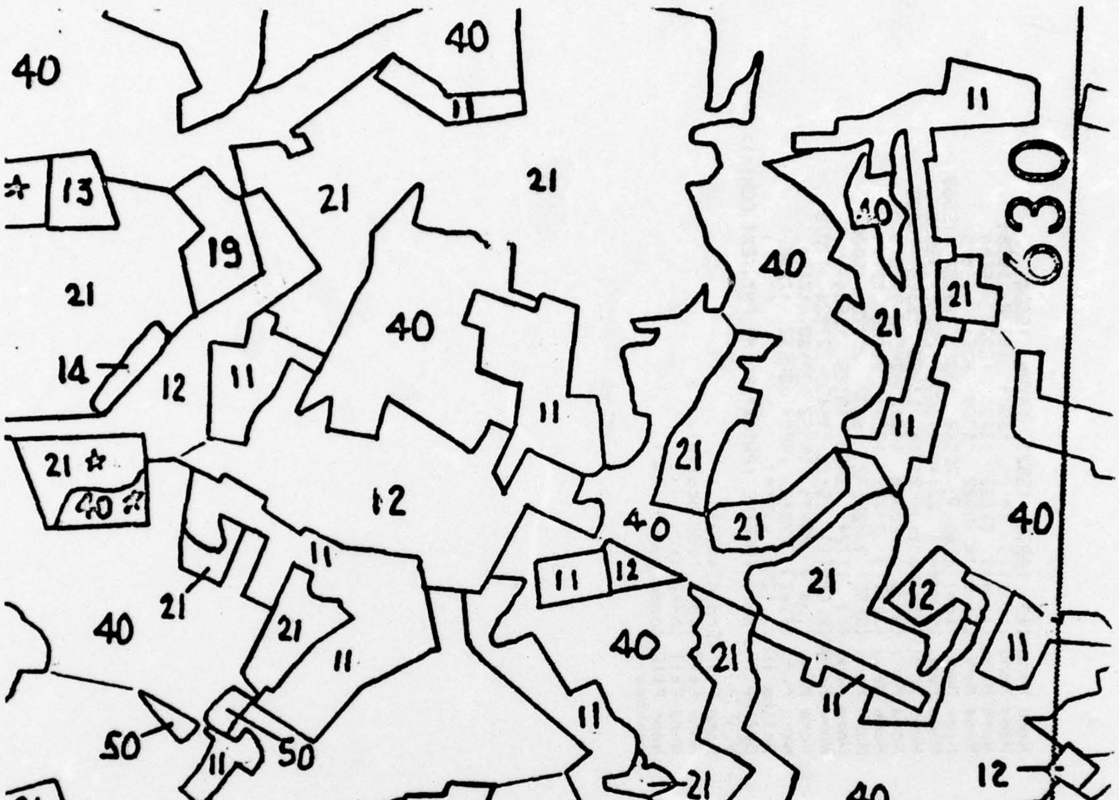
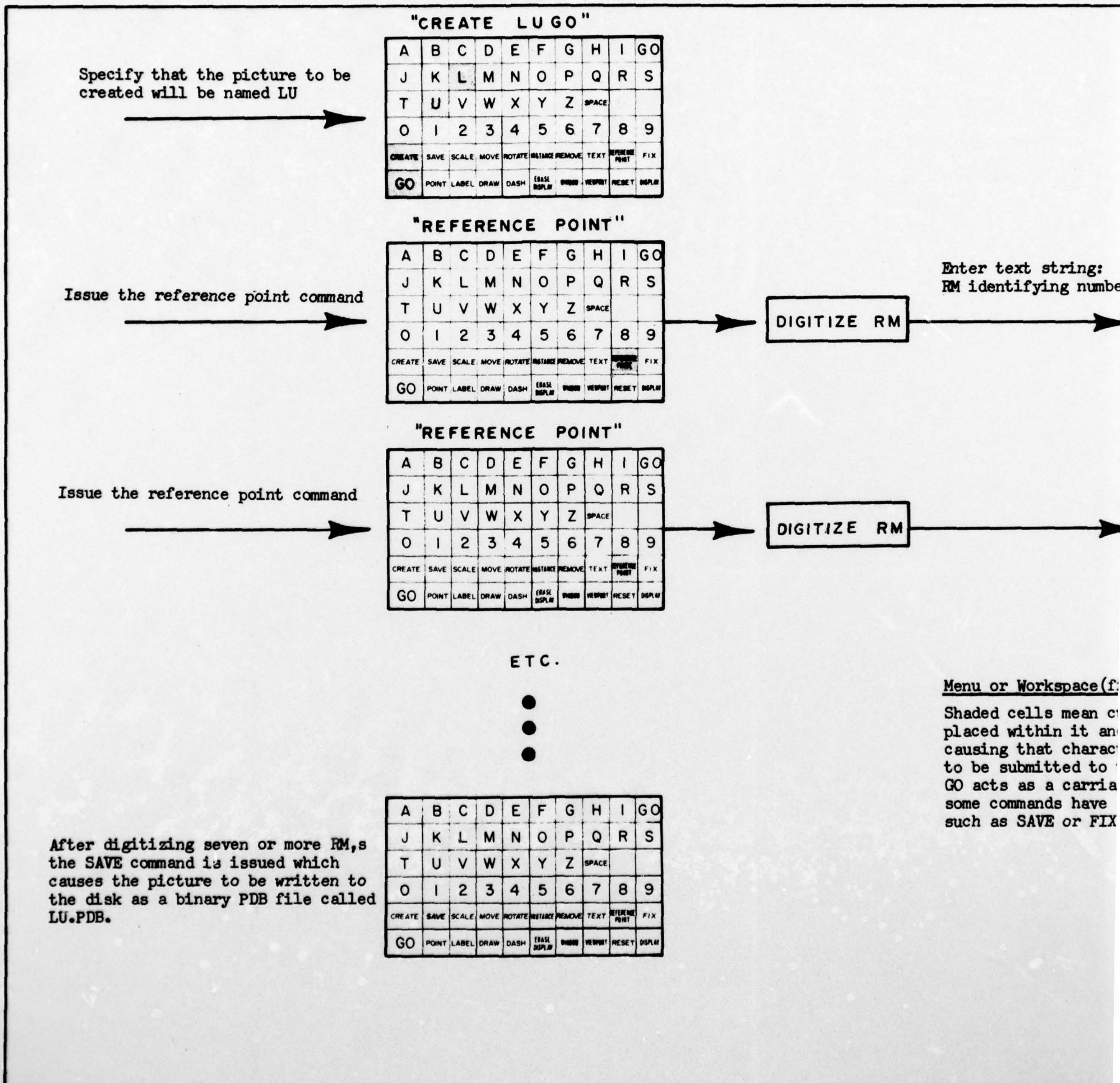
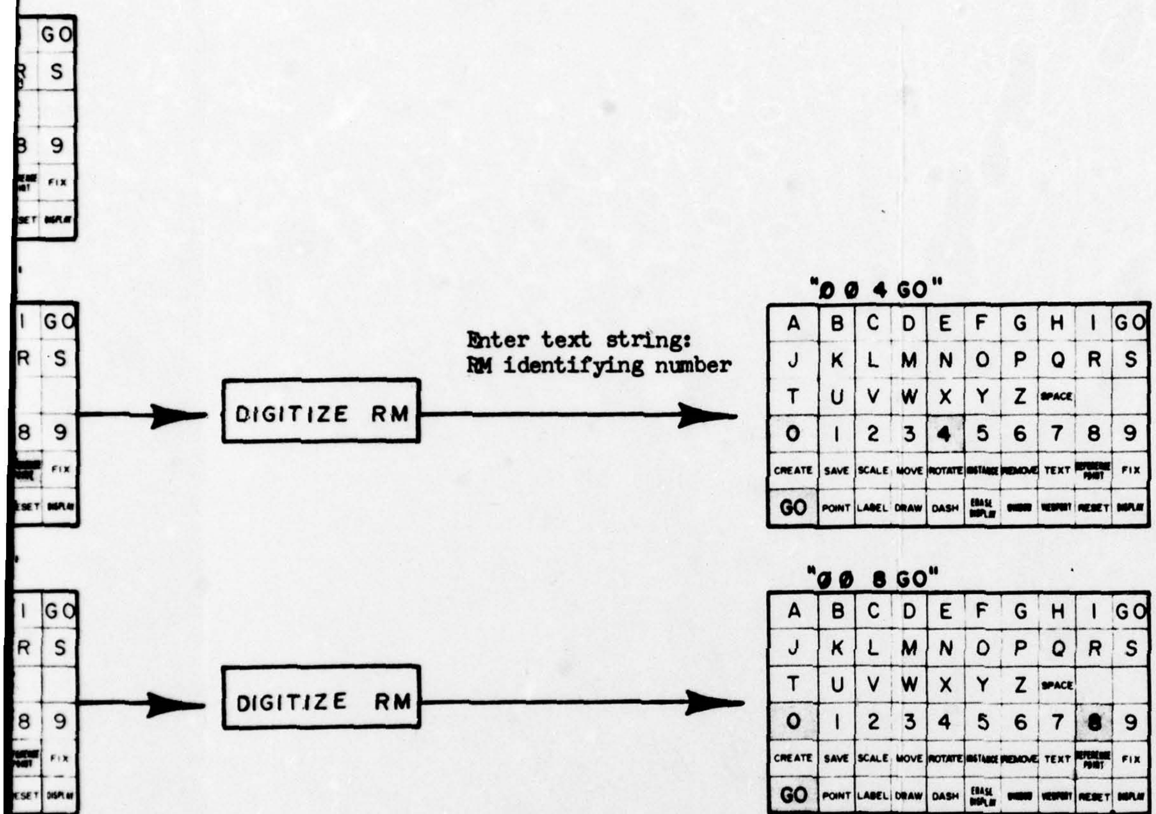
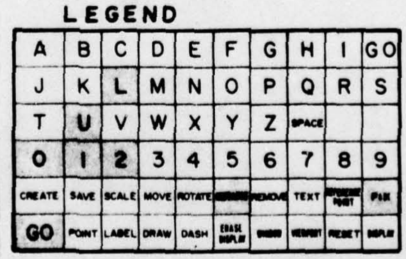


FIGURE 3


"CREATE LUGO"
Specify that the picture to be created will be named LU
"REFERENCE POINT"
Issue the reference point command
DIGITIZE RM
Enter text string:
RM identifying numbe
"REFERENCE POINT"
Issue the reference point command
DIGITIZE RM
ETC.
After digitizing seven or more RM,s the SAVE command is issued which causes the picture to be written to the disk as a binary PDB file called LU.PDB.
Menu or Workspace(f
Shaded cells mean c
placed within it an
causing that charac
to be submitted to
GO acts as a carria
some commands have
such as SAVE or FIX



LEGEND

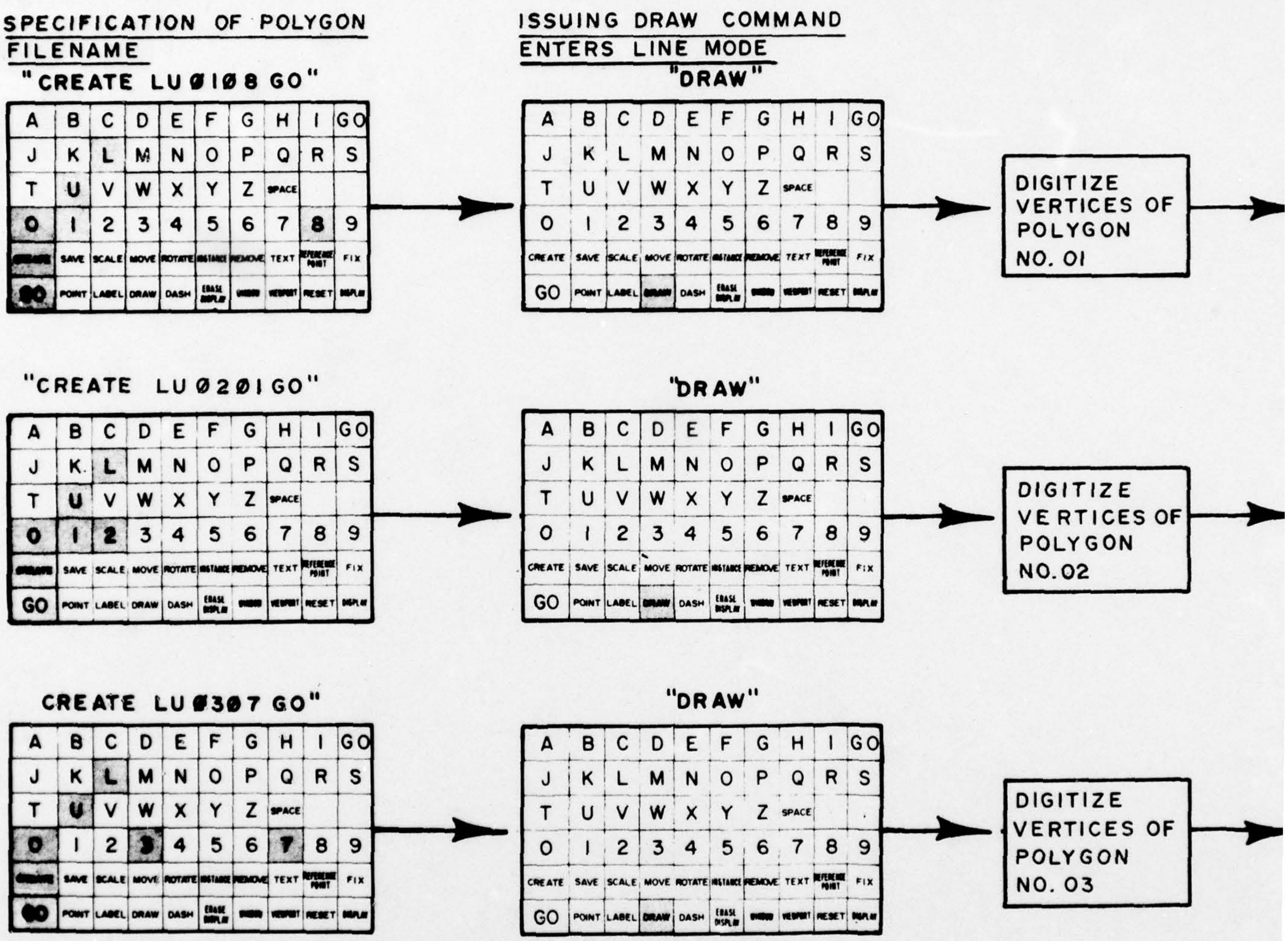


Menu or Workspace(file ACOFVE.WSP)

Shaded cells mean cursor was placed within it and activated causing that character or command to be submitted to the CPU. GO acts as a carriage return and some commands have an implicit GO such as SAVE or FIX.

DIGITIZING PROCEDURE
REFERENCE POINT DATA
(RM'S)
USING
ACOGFM

FIGURE 4



ETC.

LEGEND

Menu or Workspace(file ACOFVE.WSP)

Shaded cells mean cursor was placed within it and activated causing that character or command to be submitted to the CPU.
GO acts as a carriage return and some commands have an implicit GO such as SAVE or FIX.

AD-A062 478 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 9/2
GRAPHICS IN THE CORPS. PROCEEDINS OF THE COMPUTER GRAPHICS COLL--ETC(U)
1978 J M JONES, R L HALL, N RADHAKRISHNAN

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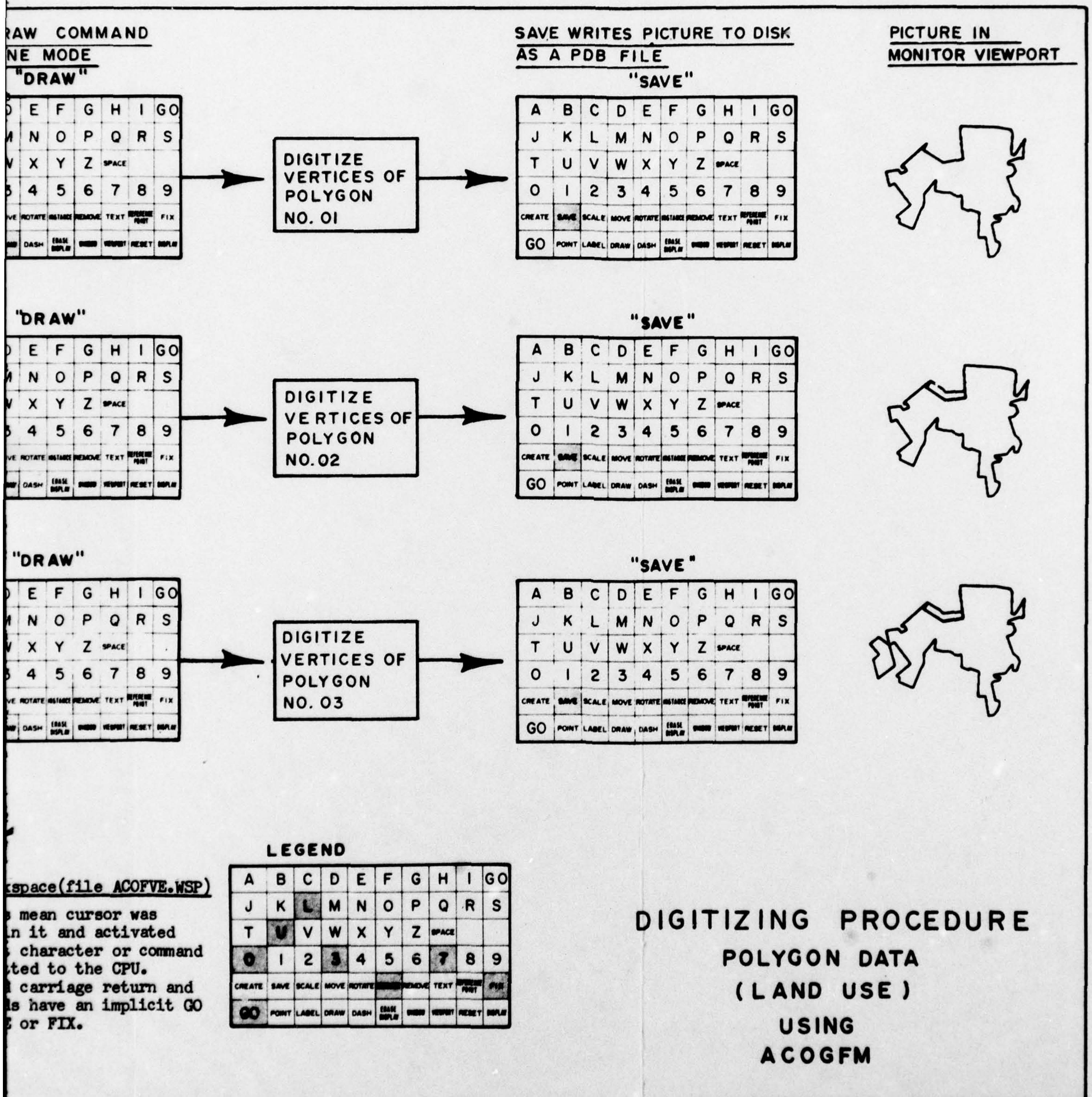
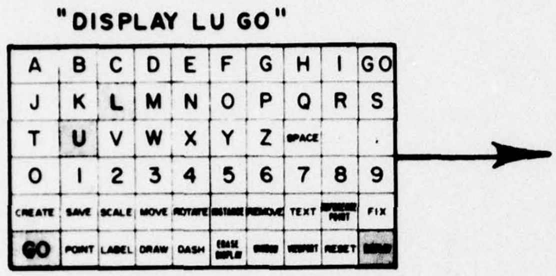
4 OF 5
AD
A062478



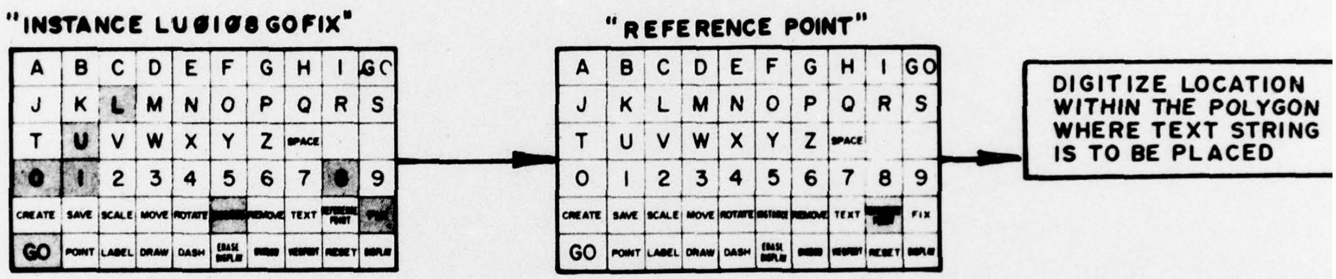
RAW COMMAND
NE MODE
"DRAW"
DIGITIZE VERTICES OF POLYGON NO. 01
SAVE WRITES PICTURE TO DISK AS A PDB FILE
"SAVE"
PICTURE IN MONITOR VIEWPORT
"DRAW"
DIGITIZE VERTICES OF POLYGON NO.02
"SAVE"
"DRAW"
DIGITIZE VERTICES OF POLYGON NO. 03
"SAVE"
kspace(file ACOFVE.WSP)
s mean cursor was
in it and activated
character or command
ted to the CPU.
carriage return and
ls have an implicit GO
or FIX.
LEGEND
DIGITIZING PROCEDURE
POLYGON DATA
(LAND USE)
USING
ACOGFM

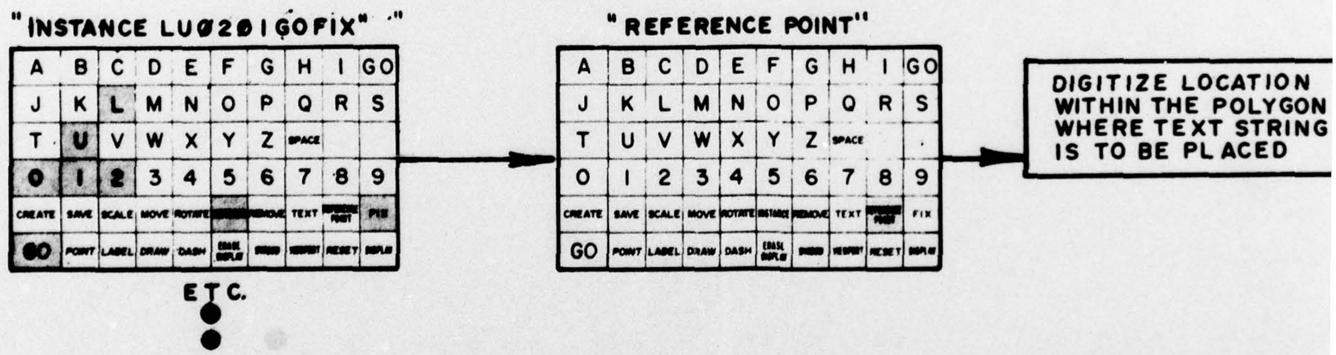
FIGURE 5

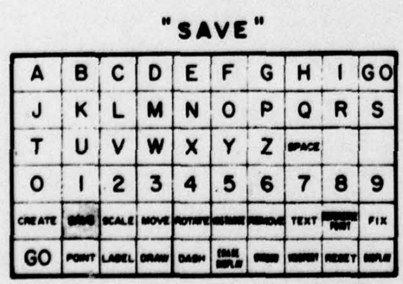
2



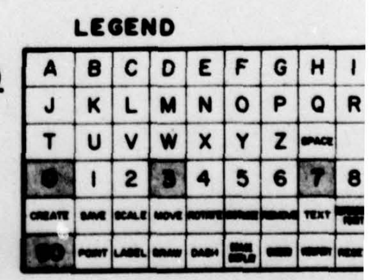
Brings file LU containing only reference point data to the
picture for updating.
The INSTANCE command brings the specified file to the scree
file LU.
The FIX command causes the instanced file to be placed in s
become part of the active picture.
The SAVE command writes the updated LU file to the disk. Se
displayed file LU.PDB.



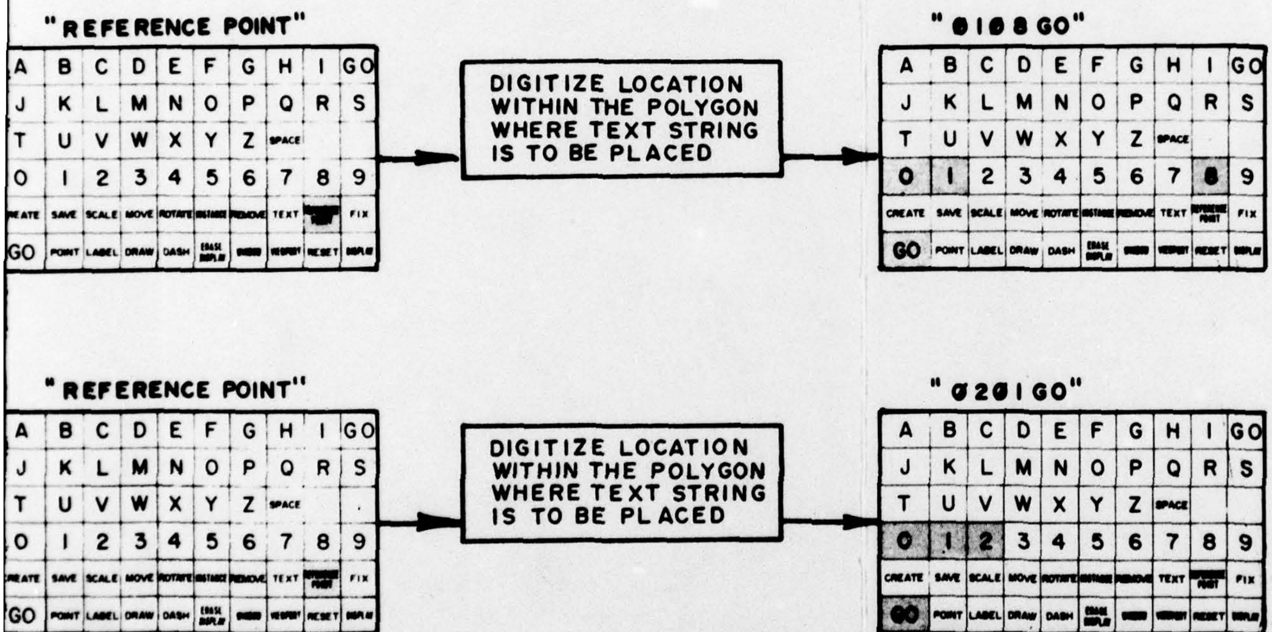


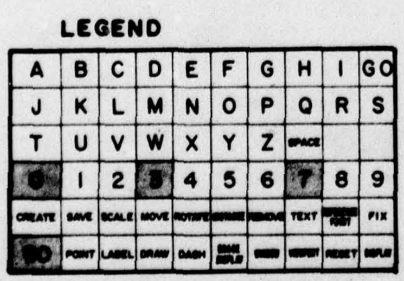


<u>Menu or Workspace(file ACOFVE.WSP)</u>
Shaded cells mean cursor was placed within it and activated causing that character or command to be submitted to the CPU.
GO acts as a carriage return and some commands have an implicit GO such as SAVE or FIX.



Brings file LU containing only reference point data to the screen as the current active picture for updating.
The INSTANCE command brings the specified file to the screen in refresh as an update to file LU.
The FIX command causes the instanced file to be placed in storage on the screen and become part of the active picture.
The SAVE command writes the updated LU file to the disk. See Figure 7 for the displayed file LU.PDB.





nu or Workspace(file ACOFVE.WSP)
aded cells mean cursor was
aced within it and activated
using that character or command
be submitted to the CPU.
acts as a carriage return and
me commands have an implicit GO
ch as SAVE or FIX.

DIGITIZING PROCEDURE
MERGING POLYGON FILES INTO MASTER FILE LU USING ACOGFM

FIGURE 6

8

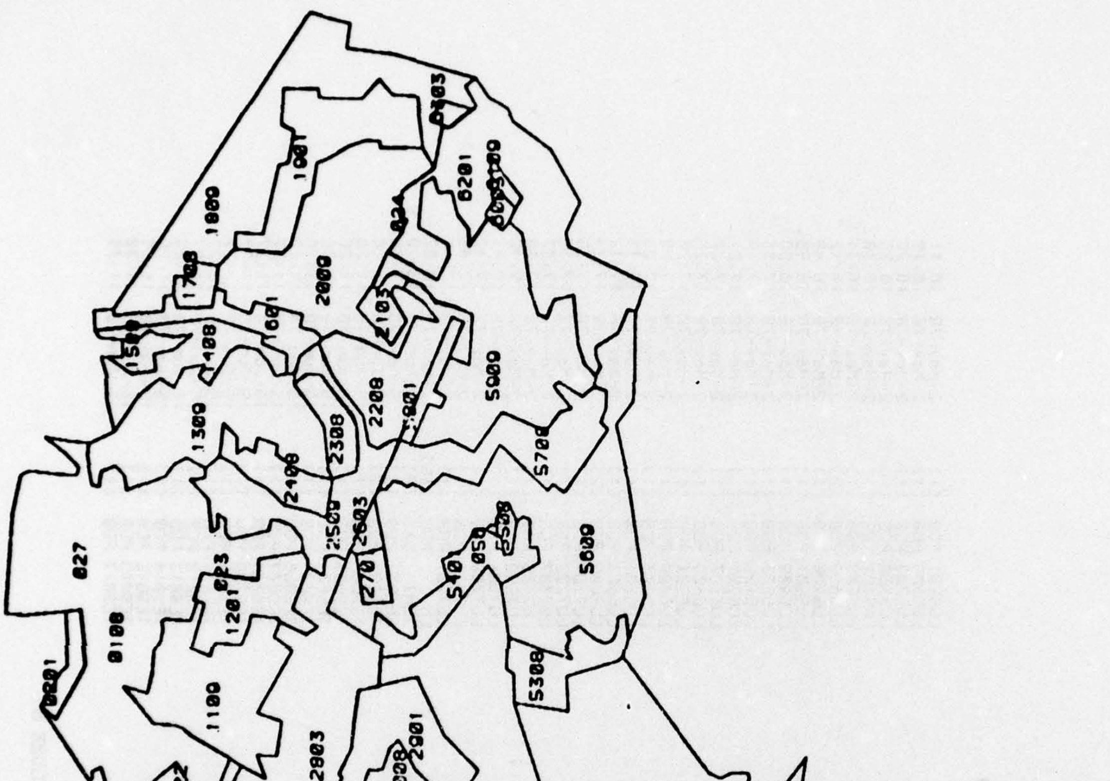


FIGURE 7

```
UIN

Directory Structure of USR:DET2   19-Apr-78
Directory Blocks: Available- 34, Used- 12

ACOFVE VSP  [12]   10-Apr-78  10:57
LU0108 PDB  [2]     2-May-78  12:53
LU0201 PDB  [1]     2-May-78  12:55
LU0307 PDB  [1]     2-May-78  12:59
LU0408 PDB  [1]     2-May-78  13:01
LU0505 PDB  [1]     2-May-78  13:02
LU0609 PDB  [1]     2-May-78  13:05
LU0703 PDB  [1]     2-May-78  13:06
LU0807 PDB  [1]     2-May-78  13:08
LU0903 PDB  [1]     2-May-78  13:10
LU1001 PDB  [1]     2-May-78  13:15
LU1109 PDB  [1]     2-May-78  13:17
LU1201 PDB  [1]     2-May-78  13:19
LU1309 PDB  [1]     2-May-78  13:22
LU1408 PDB  [1]     2-May-78  13:25
LU1509 PDB  [1]     2-May-78  13:27
LU1601 PDB  [1]     2-May-78  13:30
LU1708 PDB  [1]     2-May-78  13:31
LU1809 PDB  [1]     2-May-78  13:35
LU1901 PDB  [1]     2-May-78  13:37
LU2009 PDB  [1]     2-May-78  13:40
LU2103 PDB  [1]     2-May-78  13:42
LU2208 PDB  [1]     2-May-78  13:45
LU2308 PDB  [1]     2-May-78  13:47
LU2408 PDB  [1]     2-May-78  13:49
LU2509 PDB  [1]     2-May-78  13:52
LU2603 PDB  [1]     2-May-78  13:54
LU2701 PDB  [1]     2-May-78  13:56
LU2803 PDB  [1]     2-May-78  13:59
LU2901 PDB  [1]     2-May-78  14:02
LU3008 PDB  [1]     2-May-78  14:05
LU3108 PDB  [1]     2-May-78  14:07
LU3209 PDB  [1]     2-May-78  14:10
LU3308 PDB  [1]     2-May-78  14:13
LU3409 PDB  [1]     2-May-78  14:18
LU3507 PDB  [1]     2-May-78  14:22
LU3601 PDB  [2]     2-May-78  14:29
LU3703 PDB  [1]     2-May-78  14:32
LU3806 PDB  [1]     2-May-78  14:37
LU3909 PDB  [1]     2-May-78  15:15
LU4008 PDB  [1]     2-May-78  15:19
LU4108 PDB  [1]     2-May-78  15:26
LU4203 PDB  [1]     2-May-78  15:34
LU4301 PDB  [1]     2-May-78  15:41
LU4403 PDB  [1]     2-May-78  15:45
LU4509 PDB  [2]     2-May-78  15:53
LU4601 PDB  [1]     2-May-78  15:57
LU4701 PDB  [1]     2-May-78  16:01
LU4810 PDB  [1]     2-May-78  16:04
LU4910 PDB  [1]     2-May-78  16:07

LU5001 PDB  [1]     2-May-78  16:11
LU5109 PDB  [1]     2-May-78  16:18
LU5208 PDB  [1]     2-May-78  16:22
LU5308 PDB  [1]     2-May-78  16:26
LU5401 PDB  [1]     2-May-78  16:30
LU5508 PDB  [1]     2-May-78  16:34
LU5609 PDB  [2]     2-May-78  16:42
LU5708 PDB  [1]     2-May-78  16:48
LU5801 PDB  [1]     2-May-78  16:53
LU5909 PDB  [1]     2-May-78  16:59
LU6003 PDB  [1]     2-May-78  17:03
LU6109 PDB  [1]     2-May-78  17:19
LU6201 PDB  [1]     2-May-78  17:21
LU6303 PDB  [1]     2-May-78  17:22
LU6409 PDB  [1]     2-May-78  17:25
LU6501 PDB  [1]     2-May-78  17:26
LU6608 PDB  [1]     2-May-78  17:28
LU6703 PDB  [1]     2-May-78  17:28
LU6801 PDB  [1]     2-May-78  17:31
LU6903 PDB  [1]     2-May-78  17:32
LU7009 PDB  [2]     2-May-78  17:34
LU7101 PDB  [1]     2-May-78  17:35
LU7202 PDB  [1]     2-May-78  17:36
LU7307 PDB  [1]     2-May-78  17:37
LU7408 PDB  [1]     2-May-78  17:38
LU7509 PDB  [1]     2-May-78  17:40
LU7601 PDB  [1]     2-May-78  17:41
LU7708 PDB  [1]     2-May-78  17:42
LU7809 PDB  [1]     2-May-78  17:43
LU7901 PDB  [1]     2-May-78  17:45
LU     PDB  [15]    2-May-78  18:02
IBM7   DAT  [8]    20-Apr-78  13:19   W
CHART  PDB  [2]     5-May-78   7:48
TES001 PDB  [2]    15-Jun-78  11:26
TES002 PDB  [1]    15-Jun-78  11:26
TES003 PDB  [1]    15-Jun-78  11:26
TES004 PDB  [1]    15-Jun-78  11:26
TES005 PDB  [1]    15-Jun-78  11:26
TES006 PDB  [1]    15-Jun-78  11:26
TES007 PDB  [1]    15-Jun-78  11:27
TES008 PDB  [1]    15-Jun-78  11:27
TES009 PDB  [1]    15-Jun-78  11:27
TES010 PDB  [1]    15-Jun-78  11:27
TES011 PDB  [1]    15-Jun-78  11:27
TES012 PDB  [1]    15-Jun-78  11:27
TES013 PDB  [1]    15-Jun-78  11:29
TES014 PDB  [1]    15-Jun-78  11:29
TES015 PDB  [1]    15-Jun-78  11:30
TES016 PDB  [1]    15-Jun-78  11:30
TES017 PDB  [1]    15-Jun-78  11:30
```

FIGURE 8

```
PDBDMP LU

     Picture Data Base Dump V3 0L0. File - LU

Header FDM, Len=22
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   Extent=-3726,-3870,1081,1300

Long, Relative, Point, Len=6
   X=-2487, Y=-1082

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-2487, Y Setpoint=-1082
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=804

Long, Relative, Point, Len=6
   X=-563, Y=555

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-3030, Y Setpoint=-1307
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=805

Long, Relative, Point, Len=6
   X=1285, Y=-407

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-1745, Y Setpoint=-1834
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=808

Long, Relative, Point, Len=6
   X=497, Y=1037

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-1248, Y Setpoint=-707
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=811

Long, Relative, Point, Len=6
   X=83, Y=1201

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-1165, Y Setpoint=494
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=822

Long, Relative, Point, Len=6
   X=703, Y=-162

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-302, Y Setpoint=332
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=823

Long, Relative, Point, Len=6
   X=1350, Y=-741

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=807, Y Setpoint=-409
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=824

Long, Relative, Point, Len=6
   X=-1320, Y=1300

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-381, Y Setpoint=857
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=827

Long, Relative, Point, Len=6
   X=-2000, Y=-4230

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-2421, Y Setpoint=-3270
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=830

Long, Relative, Point, Len=6
   X=2148, Y=2487

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-273, Y Setpoint=-782
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=858

Instance FDM, Len=20
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   File Name=LU0100

Long, Relative, Point, Len=6
   X=-400, Y=1574

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-873, Y Setpoint=782
   X Scale (Hex)=2000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=0100

Instance FDM, Len=20
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   File Name=LU0201

Long, Relative, Point, Len=6
   X=-108, Y=284

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-841, Y Setpoint=1070
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=0201

Instance FDM, Len=20
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   File Name=LU0307

Long, Relative, Point, Len=6
   X=-584, Y=-406

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-1405, Y Setpoint=681
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=0307

Instance FDM, Len=20
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   File Name=LU0400

Long, Relative, Point, Len=6
   X=-451, Y=-240

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-1050, Y Setpoint=341
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=0400

Instance FDM, Len=20
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   File Name=LU0505

Long, Relative, Point, Len=6
   X=204, Y=-30

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-1502, Y Setpoint=382
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=0505

Instance FDM, Len=20
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   File Name=LU0600

Long, Relative, Point, Len=6
   X=-733, Y=-170

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-2325, Y Setpoint=120
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=0600

Instance FDM, Len=20
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   File Name=LU0703

Long, Relative, Point, Len=6
   X=-322, Y=-81

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-2047, Y Setpoint=45
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=0703

Instance FDM, Len=20
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   File Name=LU0007

Long, Relative, Point, Len=6
   X=50, Y=-05

Ascii FDM, Len=10
   Status (Hex)=0000
   X Setpoint=-2500, Y Setpoint=-50
   X Scale (Hex)=0000, Y Scale (Hex)=0000
   Rotation (Hex)=0000
   Ascii Text=0007

Instance FDM, Len=20
   Status (Hex)=0000
   X Setpoint=0, Y Setpoint=0
   X Scale (Hex)=0100, Y Scale (Hex)=0100
   Rotation (Hex)=0000
   File Name=LU0003

Long, Relative, Point, Len=6
   X=277, Y=83
```

FIGURE 9

```
PDBDMP LU0108

     Picture Data Base Dump V3.0L0, File - LU0108

Header FDM, Len-22
   Status (Hex)-0000
   X Setpoint-0, Y Setpoint-0
   X Scale (Hex)-0100, Y Scale (Hex)-0100
   Rotation (Hex)-0000
   Extent--1387,-104,267,1399

Long, Relative, Move, Len-6
   X--1170, Y-363

Long, Relative, Draw, Len-238
   X-9, Y-39
   X--36, Y-24
   X-150, Y-112
   X--160, Y-220
   X--55, Y--24
   X--25, Y-138
   X-124, Y-17
   X-29, Y--39
   X-61, Y-22
   X--20, Y-41
   X--24, Y--7
   X--10, Y-15
   X-274, Y-215
   X--43, Y--62
   X-201, Y--129
   X-211, Y-29
   X--22, Y-245
   X-5, Y-80
   X-378, Y--22
   X-144, Y--31
   X-17, Y--37
   X--10, Y--;19
   X--4, Y--87
   X-29, Y--12
   X-29, Y-34
   X-31, Y-41
   X-54, Y-80
   X--15, Y--107
   X--5, Y--84
   X--48, Y-7
   X--110, Y--27
   X--8, Y--31
   X-57, Y--7
   X-24, Y--64
   X--36, Y--43
   X--54, Y--10
   X-59, Y--170
   X-46, Y--41
   X-22, Y--51
   X--37, Y--85
   X--38, Y-0
   X--5, Y-66
   X--74, Y--83
   X--124, Y--14
   X-17, Y--29
   X-54, Y-2
   X--20, Y--34
   X--53, Y--5
   X--24, Y--17
   X-36, Y--172
   X-39, Y--10
   X-2, Y--33
   X--22, Y--59
   X--46, Y--45
   X--51, Y--4
   X--29, Y-195
   X--77, Y-0
   X-21, Y-250
   X--99, Y-34

Long, Relative, Draw, Len-66
   X--9, Y--17
   X--73, Y-29
   X-4, Y-116
   X--9, Y-15
   X--24, Y--10
   X--49, Y-10
   X--36, Y-26
   X--83, Y-5
   X--77, Y-22
   X-17, Y-104
   X--131, Y--136
   X--3, Y--94
   X--12, Y--34
   X--27, Y--34
   X--82, Y--179
   X--143, Y-65
################################
```

FIGURE 10

```
TYPE IPLS.ASC
 25.33   56.52 004
 19.70   50.97 005
 32.55   55.84 008
 37.52   45.47 011
 38.15   32.56 022
 46.08   34.18 023
 59.67   41.59 024
 46.39   27.93 027
 25.79   70.29 030
 47.27   45.32 056
 9999
  1   33.87     38.30    33.48    38.39    33.24    38.03    32.12    39.53
  1   29.92     37.93    30.16    37.38    28.78    37.13    28.61    38.37
  1   29.00     38.66    28.78    39.27    28.37    39.07    28.44    38.83
  1   28.29     38.73    26.14    41.47    26.76    41.04    28.05    43.05
  1   27.76     45.16    25.31    44.94    24.51    44.99    24.73    48.77
  1   25.04     50.21    25.41    50.38    26.60    50.28    27.47    50.24
  1   27.59     50.53    27.25    50.82    26.84    51.13    26.04    51.67
  1   27.11     51.52    27.95    51.47    27.88    50.99    28.15    49.89
  1   28.46     49.81    28.53    50.38    29.17    50.62    29.60    50.26
  1   29.70     49.72    31.40    50.31    31.81    50.77    32.32    50.99
  1   33.17     50.62    33.17    50.24    32.51    50.19    33.34    49.45
  1   33.48     48.21    33.77    48.38    33.75    48.92    34.09    48.72
  1   34.14     48.19    34.31    47.95    36.03    48.31    36.13    48.70
  1   36.46     48.72    37.05    48.50    37.50    48.04    37.54    47.53
  1   35.59     47.24    35.59    46.47    33.09    46.68    32.75    45.69
  1   32.92     45.60    32.63    44.87    31.47    44.91    31.32    44.82
  1   31.42     44.58    31.32    44.09    31.06    43.73    31.01    42.90
  1   30.79     42.13    29.75    42.30    31.11    40.99    32.05    40.96
  1   32.39     40.84    32.73    40.57    34.52    39.75    33.87    38.32
  1  999.99    999.99
 43.27   29.58 0108
  2   26.76     41.06    26.11    41.50    26.96    42.81    27.25    43.07
  2   27.11     45.09    27.73    45.18    28.03    43.07    26.76    41.06
  2  999.99    999.99
 41.59   26.74 0201
  3   33.43     36.12    31.61    35.70    31.03    36.33    29.99    35.41
  3   29.36     36.31    30.16    37.38    32.22    37.96    33.43    36.12
  3  999.99    999.99
 35.95   31.69 0307
  4   36.46     30.15    34.98    29.45    34.02    29.54    34.45    30.71
  4   34.21     30.80    33.82    30.56    33.26    30.78    31.61    35.73
```

FIGURE 11

Register (REGIST): Hydrologic Engineering Center (HEC) program to compute a least-squares surface fit of a data map to a base coordinate system by the use of match points located on both maps. This program was taken off of the Boeing Computer System and converted to run directly on the 4081. Figures 12 thru 15 show the run stream of file handling information and the results of the regression analysis on X. Input to the program is the IPL5 file and file IBM7 which contains the basemap coordinates for reference point data (BM's). The primary output is a binary file,N9.DAT, which contains the adjusted coordinates of the vertice data from file IPL5.

```
#
#
#
#
#regis!
NAME OF ASCII FILE TO BE CONVERTED:IPL5
IPL5
ENTER NAME OF INPUT FILE:IBM7
IBM7
ENTER NAME OF OUTPUT FILE FOR INPUT TO REGISTER:N3
N3
ENTER STRING FOR T1 CARD
THIS IS A DEMONSTRATION RUN
ENTER STRING FOR T2 CARD
OF THE REGISTER PROGRAM FOR
ENTER STRING FOR T3 CARD
THE COMPUTER GRAPHICS COLLOQIUM
ENTER NAMES OF INPUT/OUTPUT FILES

OUTPUT NØ.1-N8
OUTPUT NØ.2-N9
N8
N9
1THIS IS A DEMONSTRATION RUN
2OF THE REGISTER PROGRAM FOR
3THE COMPUTER GRAPHICS COLLOQIUM
1     4          3                       1
M       X OLD        Y OLD  X BASE  Y BASE
J     4          1 X**2
O    -1          1        8         5
C     2
J     4          1 Y**2
O    -2          1        8         5
C     2
J     4          Ø X*Y
O    -1          1       -2         3
R     3 1  1 1 Ø 1 1 1                                          5
T  PT  4    25.33    56.52    13.42     5.86
T  PT  5    19.70    5Ø.97    12.29     7.Ø1
T  PT  8    32.55    55.84    14.92     5.97
T  PT 11    37.52    45.47    15.99     8.Ø7
T  PT 22    38.15    32.56    16.15    1Ø.74
```

FIGURE 12

```
T  PT 23   46.08   34.18   17.74   10.37
T  PT 24   59.67   41.59   20.57    8.79
T  PT 27   46.39   27.93   17.89   11.64
T  PT 30   25.79   70.29   13.48    3.00
T  PT 56   47.27   45.32   18.00    8.08
D
J   1
O  B COEFFICIENTS FOR Y
R     4 1 1 0 1 1 1 1                                        5
J
1



*********************************
   MULTIPLE LINEAR REGRESSION

   704-G1-L2020       JAN 1975
*********************************

 THIS IS A DEMONSTRATION RUN
 OF THE REGISTER PROGRAM FOR
 THE COMPUTER GRAPHICS COLLOQIUM

   NVAL    NCOMB    IPRNT    IFRMT    IDELE     DELTA
      4        3        0        0      100    0.0000
COMBINATION  1              STEP1      1    2    3    4
                   OPERATIONCODE1     -1    1    8    5
                        CONSTANTS     1/   2.0000
COMBINATION  2              STEP1      1    2    3    4
                   OPERATIONCODE1     -2    1    8    5
                        CONSTANTS     1/   2.0000
COMBINATION  3              STEP1      1    2    3    4
                   OPERATIONCODE1     -1    1   -2    3
```

FIGURE 13

+ + + + ANALYSIS NO 1 + + + +

DEPENDENT,VARIABLE -- X BASE

IDEP	.......TRANSFORMATION CODES.......	NOBR	IRES
3	1 1 1 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	0	5

VARIABLE	TRANSFORMATION
X OLD	NONE
Y OLD	NONE
X BASE	NONE
Y BASE	NOT USED
X**2	NONE
Y**2	NONE
X*Y	NONE

INPUT DATA

OBS NO	OBS ID	X OLD	Y OLD	X BASE	X**2	Y**2	X*Y
1	PT 4	25.330	56.520	13.420	641.608	3194.508	1431.651
2	PT 5	19.700	50.970	12.290	388.089	2597.931	1004.109
3	PT 8	32.550	55.840	14.920	1059.501	3118.104	1817.591
4	PT 11	37.520	45.470	15.990	1407.750	2067.521	1706.033
5	PT 22	38.150	32.560	16.150	1455.423	1060.152	1242.164
6	PT 23	46.080	34.180	17.740	2123.364	1168.272	1575.014
7	PT 24	59.670	41.590	20.570	3560.504	1729.730	2481.675
8	PT 27	46.390	27.930	17.890	2152.031	780.083	1295.672
9	PT 30	25.790	70.290	13.480	665.122	4940.688	1812.779
10	PT 56	47.270	45.320	18.000	2234.447	2053.901	2142.276

STATISTICS OF DATA

VARIABLE	AVERAGE	VARIANCE	STANDARD DEVIATION
X OLD	37.8449	151.7166	12.3173
Y OLD	46.0669	165.4731	12.8636
X**2	1568.7832	936250.6875	967.5979
Y**2	2271.0872	1565673.0000	1251.2637

FIGURE 14

X*Y	1650.8945	194899.5625	441.4722	
X BASE	16.0450	6.6022	2.5695	DEPENDENT VARIABLE

SIMPLE CORRELATION COEFFICIENTS

VARIABLE	X OLD	Y OLD	X**2	Y**2	X*Y	X BASE
X OLD	1.0000	-0.5903	0.9860	-0.5917	0.5613	0.9999
Y OLD	-0.5903	1.0000	-0.5302	0.9888	0.0000	-0.6015
X**2	0.9860	-0.5302	1.0000	-0.5387	0.5941	0.9854
Y**2	-0.5917	0.9888	-0.5387	1.0000	0.0000	-0.6027
X*Y	0.5613	0.0000	0.5941	0.0000	1.0000	0.5498
X BASE	0.9999	-0.6015	0.9854	-0.6027	0.5498	1.0000

INDEPENDENT VARIABLE	REGRESSION COEFFICIENT	PARTIAL DETERMINATION COEFFICIENT
X OLD	0.187661	0.9743
Y OLD	-0.024426	0.2295
X**2	0.000081	0.0962
Y**2	0.000121	0.1296
X*Y	0.000272	0.1296

REGRESSION CONSTANT	R SQUARE	R BAR SQUARE	STANDARD ERROR OF ESTIMATE
9.218736	1.0000	1.0000	0.0172

DEPENDENT VARIABLE X BASE

OBS NO	OBS ID	OBSERVED	CALCULATED	RESIDUAL
1	PT 4	13.420	13.418	0.002
2	PT 5	12.290	12.289	0.001
3	PT 8	14.920	14.919	0.001
4	PT 11	15.990	15.976	0.014
5	PT 22	16.150	16.166	-0.016
6	PT 23	17.740	17.772	-0.032
7	PT 24	20.570	20.571	-0.001
8	PT 27	17.890	17.862	0.028
9	PT 30	13.480	13.484	-0.004

FIGURE 15

Basemap (BASEMP): The basemap program is a subpackage of a proprietary program called AUTOMAP II acquired by HEC for Corps-wide use. It also was taken off of the Boeing system and converted to run on the 4081. Basemap generates a grid cell representation of point, line and areal data. Figure 16 shows the stream of file handling, titling and grid cell specification statements and Figures 17 thru 19 show typical screen output of vertice to grid cell assignments. Figure 20 indicates that 720 records were output for 79 areas or land use polygons. These were written to binary file N10.DAT. Also, any line printer map of this data would be 74 rows (characters) down the page and 223 columns (characters) across the page.

```
basemp
BASEMAP OUTPUT FILE-BMIF-WILL BE N10
N10
AUTOMAP II - BASE MAP PROGRAM

ENVIRONMENTAL SYSTEM RESEARCH INSTITUTE
380 NEW YORK STREET
REDLANDS, CALIFORNIA, U.S.A. 92373

ENTER PACKAGE DESIRED: T-TITLE ,S-SIZE ,C-CONVERSION
T


TITLE PACKAGE
-------------

DEMO FOR COMPUTER GRAPHICS COLLOQIUM
DEMO FOR COMPUTER GRAPHICS COLLOQIUM
ENDT
ENTER PACKAGE DESIRED: T-TITLE ,S-SIZE ,C-CONVERSION
C
VERTICAL SCALE FACTOR: EXAMPLE 8.5
6.
HORIZONTAL SCALE FACTOR: EXAMPLE 10.5.
10.
ROW SHIFT: EXAMPLE 125.

COLUMN SHIFT: EXAMPLE 305.

AREA SCALE FACTOR: EXAMPLE 2000.
2000.


CONVERSION PACKAGE
------------------

VERT SCALE  -        6.000
HORZ SCALE  -       10.000
ROW SHIFT   -        0.000
COL SHIFT   -        0.000
AREA SCALE  -     2000.000

ENTER PACKAGE DESIRED: T-TITLE ,S-SIZE ,C-CONVERSION
V.


VERTICE PACKAGE
---------------
INPUT WILL BE READ FROM DEVICE 0
ENTER N0 FOR CORRECT FILE TO BE PROCESSED
```

FIGURE 16

N9

AREA 1	VERTICAL	HORIZONTAL	ROW	COL	SYMBOLS	
	10.454	16.100	63	162	0	1
	10.533	16.209	63	162		
	10.502	16.137	63	161		
	10.807	16.448	65	164		
	11.254	16.139	68	161		
	11.206	16.026	67	160		
	11.484	15.985	69	160		
	11.510	16.236	69	162		
	11.439	16.292	69	163		
	11.483	16.417	69	164		
	11.566	16.379	69	164		
	11.552	16.330	69	163		
	11.583	16.311	69	163		
	12.015	16.878	72	169		
	11.890	16.788	71	168		
	11.628	17.185	70	172		
	11.684	17.614	70	176		
	12.181	17.583	73	176		
	12.343	17.599	74	176		
	12.295	18.361	74	184		
	12.230	18.650	73	187		
	12.154	18.683	73	187		
	11.913	18.658	71	187		
	11.735	18.645	70	186		
	11.710	18.704	70	187		
	11.779	18.765	71	188		
	11.862	18.829	71	188		
	12.024	18.942	72	189		
	11.826	18.907	71	189		
	11.635	18.894	70	189		
	11.650	18.797	70	188		
	11.598	18.572	70	186		
	11.535	18.554	69	186		
	11.519	18.670	69	187		
	11.388	18.716	68	187		
	11.301	18.642	68	186		
	11.282	18.531	68	185		
	10.933	18.646	66	186		
	10.848	18.738	65	187		
	10.743	18.782	64	188		
	10.569	18.704	63	187		
	10.570	18.626	63	186		
	10.706	18.618	64	186		
	10.538	18.404	63	185		
	10.513	18.210	63	182		
	10.453	18.244	63	182		
	10.455	18.354	63	184		
	10.386	18.312	62	183		
	10.378	18.204	62	182		
	10.343	18.154	62	182		
	9.990	18.223	60	182		
	9.968	18.303	60	183		

FIGURE 17

9.900	18.300	59	183
9.779	18.259	59	183
9.680	18.164	58	182
9.682	18.059	58	181
10.083	18.005	60	180
10.085	17.847	61	178
10.596	17.898	64	179
10.668	17.698	64	177
10.634	17.679	64	177
10.695	17.531	64	175
10.931	17.544	66	175
10.962	17.527	66	175
10.942	17.477	66	175
10.963	17.378	66	174
11.016	17.306	66	173
11.028	17.138	66	171
11.074	16.983	66	170
11.284	17.023	68	170
11.016	16.758	66	168
10.826	16.739	65	167
10.751	16.712	65	167
10.682	16.656	64	167
10.319	16.479	62	165
10.454	16.192	63	162

CALCULATED CENTROID 67.7 176.5
CALCULATED AREA 6725.711

AREA 2	VERTICAL	HORIZONTAL	ROW	COL	SYMBOLS	
	11.890	16.792	71	168	1	2
	12.021	16.885	72	169		
	11.849	17.143	71	171		
	11.790	17.194	71	172		
	11.816	17.603	71	176		
	11.691	17.618	70	176		
	11.632	17.189	70	172		
	11.890	16.792	71	168		

CALCULATED CENTROID 70.7 171.0
CALCULATED AREA 251.822

AREA 3	VERTICAL	HORIZONTAL	ROW	COL	SYMBOLS	
	10.546	15.749	63	157	7	3
	10.914	15.676	65	157		
	11.031	15.008	66	158		
	11.241	15.036	67	156		
	11.308	15.816	68	158		
	11.206	16.026	67	160		
	10.789	16.129	65	161		
	10.546	15.749	63	157		

CALCULATED CENTROID 65.0 158.0
CALCULATED AREA 409.986

FIGURE 18

AREA 4	VERTICAL	HORIZONTAL	ROW	COL	SYMBOLS	
	9.938	14.519	60	145	8	4
	10.230	14.309	61	144		
	10.431	14.415	63	144		
	10.344	14.647	62	146		
	10.392	14.667	62	147		
	10.471	14.622	63	146		
	10.504	14.871	64	147		
	10.914	15.682	65	157		
	10.546	15.749	63	157		
	10.413	15.607	62	156		
	10.502	15.525	63	155		
	10.252	15.306	62	153		
	10.047	15.151	60	152		
	9.973	15.209	60	152		
	9.938	14.519	60	145		

CALCULATED CENTROID 62.3 150.5
CALCULATED AREA 1453.063

AREA 5	VERTICAL	HORIZONTAL	ROW	COL	SYMBOLS	
	10.053	15.151	60	152	5	5
	10.252	15.306	62	153		
	10.502	15.525	63	155		
	10.419	15.601	63	156		
	10.320	15.549	62	155		
	9.973	15.209	60	152		
	10.047	15.151	60	152		

CALCULATED CENTROID 61.5 153.8
CALCULATED AREA 143.599

AREA 6	VERTICAL	HORIZONTAL	ROW	COL	SYMBOLS	
	9.703	13.553	58	136	9	6
	9.910	13.568	59	136		
	10.238	14.380	61	144		
	9.932	14.519	60	145		
	9.967	14.320	60	143		
	9.882	13.746	59	137		
	9.720	13.746	58	137		
	9.703	13.553	58	136		

CALCULATED CENTROID 59.9 140.4
CALCULATED AREA 353.786

AREA 7	VERTICAL	HORIZONTAL	ROW	COL	SYMBOLS	
	9.230	13.200	55	132	3	7
	9.456	13.002	57	131		

FIGURE 19

```
           4.090         13.241    25    132
           4.091         13.435    25    134
           3.610         13.443    22    134
           3.129         13.555    19    136
           3.120         13.635    19    136
           2.417         13.658    14    137
           2.374         13.557    14    136
           2.002         13.450    16    135
           2.479         13.170    15    132
           2.987         13.013    17    130
           2.922         12.659    18    127
CALCULATED CENTROID                10.5  132.3
CALCULATED AREA      1400.702
ENTER PACKAGE DESIRED: T-TITLE,S-SIZE,C-CONVERSION
E


END PACKAGE
-----------

     720 RECORDS OUTPUT FOR   79 AREAS


SIZE PACKAGE
------------

MAP SIZE IS  74 ROWS BY 223 COLUMNS
Stop 1
Exit
#
```

FIGURE 20

After running basemap, a utility was run to convert the binary N10 file to an ASCII file called N4.DAT. Figure 21 shows the type of data in N4. The grid cell representation of polygon number one is contained in the first 27 records, each record specifying the columnar extent of a polygon along a given row. For example, record number 15 specifies that polygon number 01 extends from column 173 to column 187 along row 66. This data is now ready to be transmitted by the 4081 to the Boeing Computer System (or to any other host) for insertion into the data bank.

type n4 dat

59	1	181	183	0	1
60	2	180	182	0	1
61	3	179	182	0	1
62	4	165	165	0	1
62	5	179	182	0	1
63	6	162	166	0	1
63	7	179	182	0	1
64	8	163	167	0	1
64	9	176	177	0	1
64	10	177	186	0	1
64	11	187	188	0	1
65	12	164	168	0	1
65	13	176	188	0	1
66	14	163	168	0	1
66	15	173	187	0	1
67	16	162	169	0	1
67	17	170	186	0	1
68	18	160	187	0	1
69	19	161	162	0	1
69	20	164	187	0	1
70	21	164	171	0	1
70	22	175	189	0	1
71	23	166	168	0	1
71	24	176	187	0	1
71	25	188	190	0	1
72	26	176	187	0	1
73	27	176	187	0	1
70	28	171	175	0	2
71	29	169	171	0	2
64	30	157	159	0	3
65	31	157	161	0	3
66	32	158	161	0	3
67	33	157	160	0	3
68	34	157	158	0	3
60	35	145	152	0	4
61	36	144	152	0	4
62	37	144	146	0	4
62	38	146	154	0	4
63	39	146	155	0	4
63	40	155	157	0	4
64	41	149	157	0	4
65	42	154	157	0	4

FIGURE 21

Summary

The Pittsburgh District has only scratched the surface of the graphic capabilities of the Tektronix 4081 and the field of Interactive Graphics in general. Both can play an important role in the future not only in Flood Plain Information studies of the type described in this demonstration but also in support of the overall Corps mission. We appreciate the opportunity to share this information with you.

Summary

From these presentations its obvious that the use of interactive graphics devices are becoming widely used within the Corps. With the growth of these devices going from 2 in 1970 to 85 in 1978 many problems have arisen. These problems have been in the area of terminal procurement, support software, training and adequate computer support.

With the rapid growth of many graphics devices, the graphics terminal buyer is often confused as to which device will truly meet a particular office's needs. As seen by the hardware survey, Tektronix is by far the leading supplier of interactive graphics terminals to the Corps. However, Tektronix themselves offer a variety of graphic terminals with abundant options for each terminal. The Corps must continually be very cautious as to the hardware it purchases. It is very easy to spend several thousands dollars to purchase an unsatisfactory piece of equipment. The Corps must have a strong line of communication between offices to gain information about the performance of existing equipment in order to make judgments for further purchases. Procedures needs to be developed to examine new equipment and options to existing equipment, in order for Corps to make correct steps to stay near the state-of-the-art in computer graphics. However, with a purchase, the buyer should also be concerned with the transportability of the graphics applications developed on a particular device.

Much of the transportability of an application can be done with the proper graphics software package. The two most used packages are PLOT-10 supported by Tektronix and the Graphics Compatibility System (GCS) supported by the Waterways Experiment Station. Both software packages are made up of FORTRAN callable subroutines and both provide all the needed commands for developing a graphics applications for a storage tube terminal. However, GCS has the capabilities of allowing an application to use several different device, i.e., device independent.

Both PLOT-10 and GCS are on several computers allowing the program to be machine independent. The Corps needs to use and to support a graphics language that will allow graphics application to have both machine and device independence. The software package needs to be available to all Corps offices and running on the major computer service supporting the Corps.

The package also should be supported with training available to all Corps offices.

A class entitled, "Computer Applications for Engineers and Engineering Managers", has offered training in using GCS. However, no training has been offered to training Corps personnel on techniques of using a software package for development of an interactive program.

However, the major problem with the development of an interactive graphics program has been the lack of adequate computer support. Studies have indicated that in order for engineers to properly interact with a computer program, he must have the ability to interact on an average of once every two or three seconds. Unfortunately, most timesharing systems will not give this needed interaction. Also, in order to use this interaction with graphics the user needs a minimum of 2400 baud. Again, this is generally not available to must Corps offices.

Also, from these presentations, it is observed that many of these problems have been overcome. Interactive graphics can be a method for man-machine communication. Although the Corps may not be using the latest hardware on graphic techniques, these demonstrations prove that the Corps is using interactive graphics as an effective tool to input data and to interpret results from digital computers.

PASSIVE WORKSHOP

PASSIVE GRAPHICS SESSION
Co-Chairmen - John Lambrecht/Bob Williams

Both passive graphics sessions were well attended and had several lively discussions among the participants.

The following districts made presentations on what they were doing:

Nashville	John Lambrecht
Kansas City	Bob Williams
Charleston	Jim Black
SWD	Jim Bussell
New Orleans	Charles Kenney
Pittsburgh	Lowell Hoy
Pittsburgh	Henry Edwardo (Digitizing)
OCE	Harry Hardin (State Boundries)
Savannah	Marie Roberts (Dam Crack Survey)
Rock Island	Lee Swanson (RAPM, Obligations & Expenditures, Slope Stability)
Norfolk	Ralph Moses
CERL	Janet Spoonamore
HEC	Art Pabst
ETL	Wes Shepherd
Vicksburg	Pam Sanders
St. Louis	Joe Hartman
St. Louis	Tom Wolff
Louisville	Bob Beck
Walla Walla	Gus Kajita
Philadelphia	Carl Doughty
Huntington	Larry Murphy
Ft. Worth	Al Montalvo
SPD	Clyde Okazaki
Sacramento	Jerry Herrigstad
Mobile	
St. Paul	Mike Downs
Portland	Randy Dickinson

At both sessions, Daryl Bradstreet, Seattle District gave a presentation on the Roadway Design System.

Several messages came through as to what the users and ADP people want GUC to do. Some of these items are not within our power to do but we will try to get them to the proper people for action.

1. Help is needed on getting plot tapes from Boeing. Whenever OCE gives us a new system (either contract, hardware or software) better dissemination of how to interface with the system is needed. It was brought out that Rock Island got the Corps UT 200 to interface Gerber with Boeing and Kansas City got Calcomp to interface with Boeing.

2. Several districts are using contouring and 3D packages of Calcomp. These programs have been on various stages of loan and should be purchased for Corps-wide use.

3. Only three business applications were mentioned. These by one district, Rock Island. They were RAPM Network Plots, Organization Chart Plots and an Expenditure and Obligation Plot. There is a big area of applications particularly if we can interface with the COEMIS Data Base.

4. Investigate cheaper methods of digitizing data and still allow editing of the data without being on-line to a host (particularly a contract host). This could include micros tied to graphics terminals for editing.

5. A general course on data communications is needed. Nashville mentioned two excellent courses (one week and two week) ATT conducts on all phases of telecommunications. This includes line protocol, modems, etc. We need a general course in laymens terms for the users so they can understand what the ADP people are talking about. This lack of non-ADP people training is one of many problem areas brought out in the Federal Data Processing Reorganization Study of The President's Reorganization Project.

6. Another point brought out is a long standing problem we in ADP have had. Documentation!!! A new aspect of this was that in some districts when documentation was received in ADP it never got past the Chief of ADP's desk. The users were not aware of what was going on.

7. Philadelphia suggested a Who's Who on special problems such as who is the expert on Cope 1200 or Gerber, etc. Certain individuals in the districts have become experts in various specific areas due to necessity and/or special interests. Some of us are aware of these people, others are not. This information should be disseminated.

8. Problems in standardization were brought up. One very interesting thought discussed was where does or where should personal choice end and standardization begin. One point strongly made was that any standard and the people controlling/maintaining the standard must be responsive to the users needs for changes/corrections and must be responsive in a timely manner.

9. ETL brought out a need for possible standardization of Terrain Data Base Structures. There were also needs expressed for Standardized Data Base Structures in several areas such as Hydrology, Core Boring and other areas.

10. A need for graphics training was expressed. WES already is conducting courses in this area as are some districts. This information is not getting to the right people.

11. Several discussions came about to dissemination of information. Reviving of EP 18-1-3 was discussed. It is being studied. An interim on-line version will be implemented on Boeing just for graphics applications while the reviving of an on-line version of EP 18-1-3 is being studied. The main bottleneck appears to be a coding system for programs. Also available is the Engineering Computer Notes published by WES. Any articles about your program will be accepted.

12. In regard to Engineer Computer Notes (ECN) we got the impression not everyone who needs it is getting to see it. Maybe the mailing list should be cleaned up by adding the attendees here and sending a questionnaire with the next mailing.

ROADWAY DESIGN SYSTEM - by Daryl J. Bradstreet

SYSTEM FEATURES RDS is a computerized roadway design system. It is comprised of over 400 Fortran subroutines and four IBM assembler subroutines totaling over 60,000 source statements, all combined into one executable load module.

It is designed to execute on a IBM 360 or 370 computer in less than 250K bytes of core memory.

It is executed in a batch environment and requires temporary disk space for work data sets and a tape drive for plot output to an offline Calcomp plotter.

The average run time for a job with 60 cross-sections to produce design quantities and supporting plots is less than 60 CPU seconds on an IBM 370 Model 155.

HISTORICAL DEVELOPMENT RDS was developed during the period of 1967 to to 1971 by the Texas State Department of Highways and Public Transportation, under contract to the Federal Highway Administration.

In 1974 it was put into use as a production tool for roadway design by the Federal Highway Administration and released to other interested agencies.

In 1976, an RDS user group was formed and currently meets once a year at the national meeting of the Highway Engineers Exchange Program (HEEP). The purpose of the user group is to provide cooperative technical support and to encourage RDS as a national road design system.

SYSTEM PROCESSES RDS is divided into five major system processes: 1) Geodetic Control; 2) Command Structure; 3) Terrain Reduction; 4) Design Data; and 5) Supporting Graphics.

The geodetic control may be used to reduce geodetic information and establish primary horizontal control points.

The command structure process consists of 54 fixed format type commands that provide coordinate and bridge geometry and general plotting capabilities.

The terrain reduction process stores original or final cross-sections and provides a limited amount of terrain modification, such as changing elevations at a station or interpolating or extrapolating an additional cross-section.

The design process allows the specification of up to six individual roadways using design data such as:

Horizontal and vertical alignments

Roadway template shapes

Super elevations and widening medians

Side slope selection patterns

Once all the design data is specified, any combination of roadways may be designed and reports such as horizontal alignment, profile grades, alignment relations, slope staking, and quantities may be requested.

GRAPHIC SUPPORT RDS graphic support is a combination of integrated and stand alone software using standard Calcomp calls.

The geometric plotting of points, circles, lines, and labels, and the plotting of horizontal alignments, roadway surface contours and plan plots

are requested through the command structure process. Any combination of these plots may be requested and overlayed.

Cross sections, profiles and haul plots are requested as a separate process.

The perspectives and contour plots are stand alone programs that access a XYZ data file generated by RDS.

ADVANTAGES

- Excellent documentation
- Easy to use (one executable load module)
- Good graphic support
- Active user group (12 state highway departments)
- Price is right (non-proprietory)

DISADVANTAGES

- IBM hardware dependent (IBM assembler routines)
- 200 points design, 150 points final
- Stage development separate run
- No interactive capabilities

FUTURE

- Extend maintenance contract to include documentation distribution, education and enhancements.
- FHWA procurement of minicomputers and possible installment of RDS.
- Improved graphics.

DISTRIBUTION

23 states	14 foreign countries
12 public agencies	7 colleges and universities
35 consultants	

USER GROUP CONTRIBUTORS

Georgia	North Carolina
Idaho	Texas
Maryland	Utah
Michigan	Wyoming
Nebraska	FHWA
Nevada	

CONTACTS

Support - NPD Version

Department of the Army
Corps of Engineers, Seattle District
ATTN: Mr. Daryl Bradstreet, ADPC
P.O. Box C-3755
Seattle, WA 98124
PHONE: (FTS) 399-3696

Access - NPD IBM 370/155

Department of the Army
Corps of Engineers, North Pacific Division
ATTN: Mr. Loren Shoemaker, ADPC
P.O. Box 2870
Portland, OR 97208
PHONE: (FTS) 423-3714

Distribution

Federal Highway Administration
Highway Design Division
ATTN: Mr. William Lai
400 7th Street, S.W.
Washington, DC 20590
PHONE: 202-426-0320

Plot Samples of Walla Walla District
by Gus Kajita

Exhibit 1. Flood Profile plot

Exhibit 2. Summary Hydrograph plot

Exhibit 3. Isometric Plot W/Crack survey overlay

The programs above are written in FORTRAN IV using the CalComp plot subroutine calls.

For further information please contact:

Cecil Ashley, ADP Coordinator
Walla Walla District, Corps of Engineers
Bldg 602, City-County Airport
Walla Walla, Washington 99362
FTS 442-5446

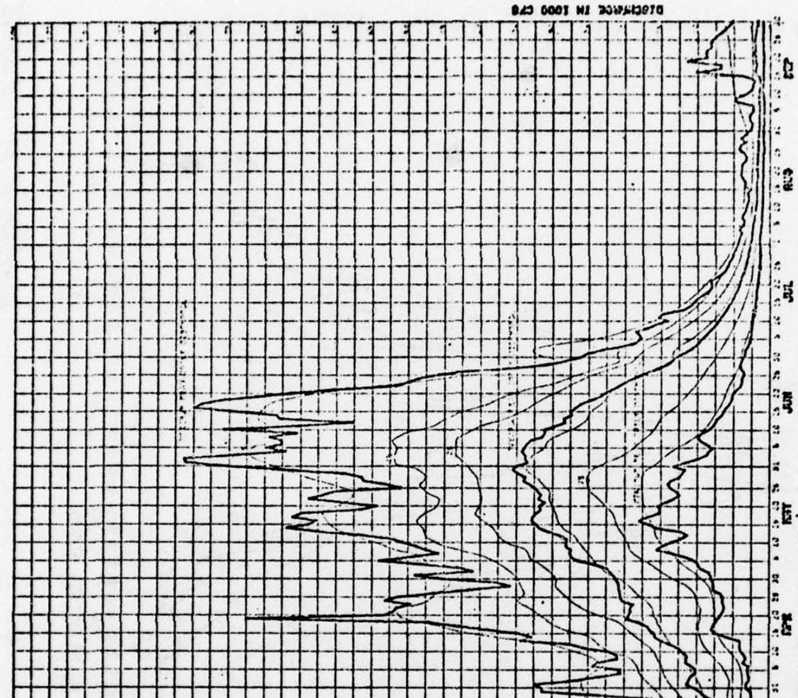


Exhibit 2, 1 of 2

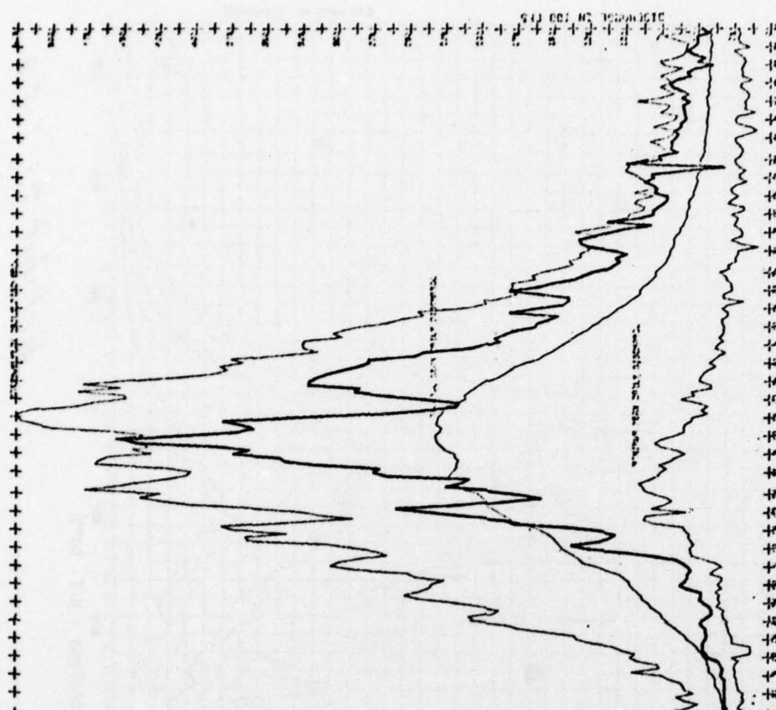
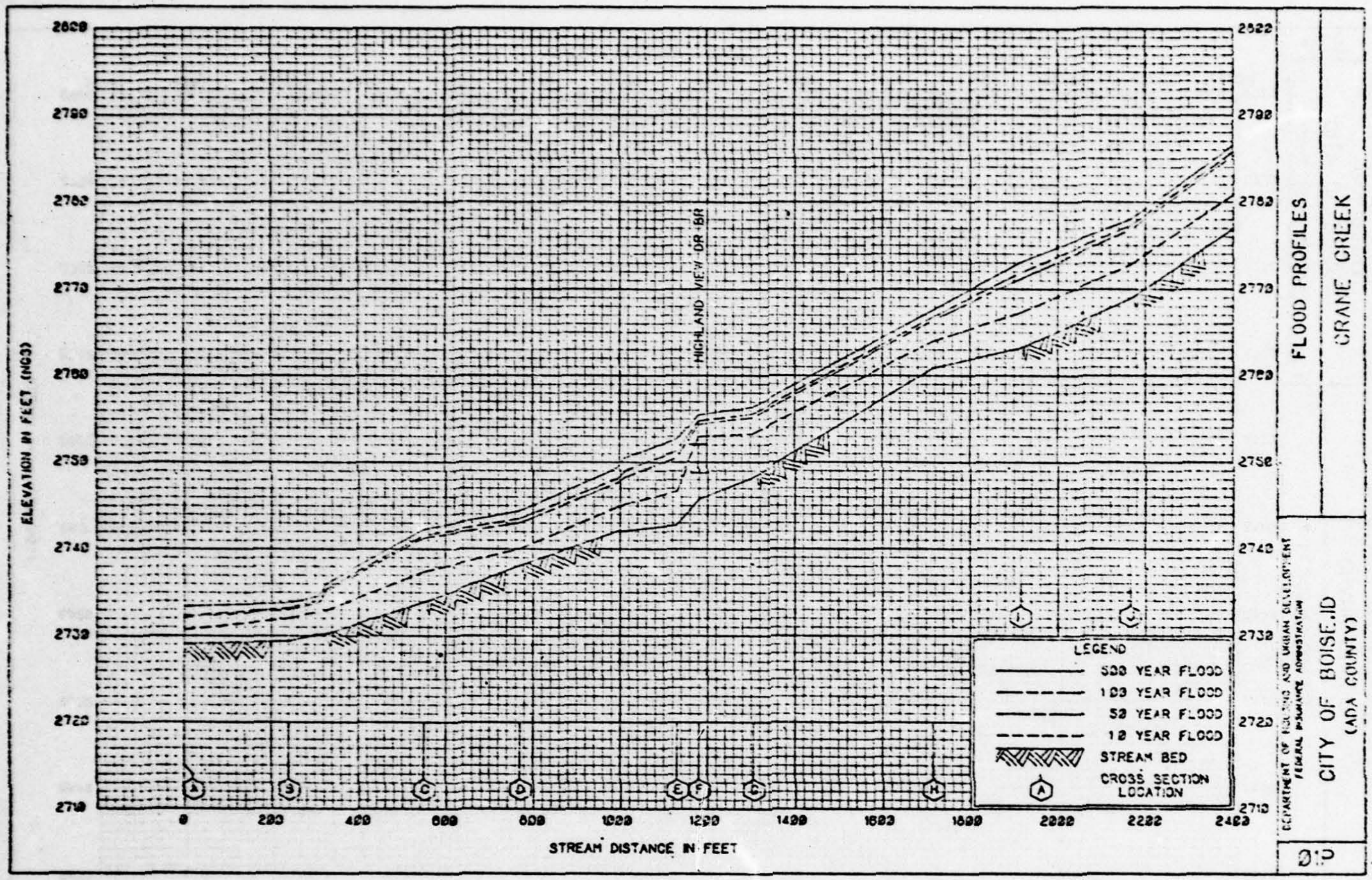
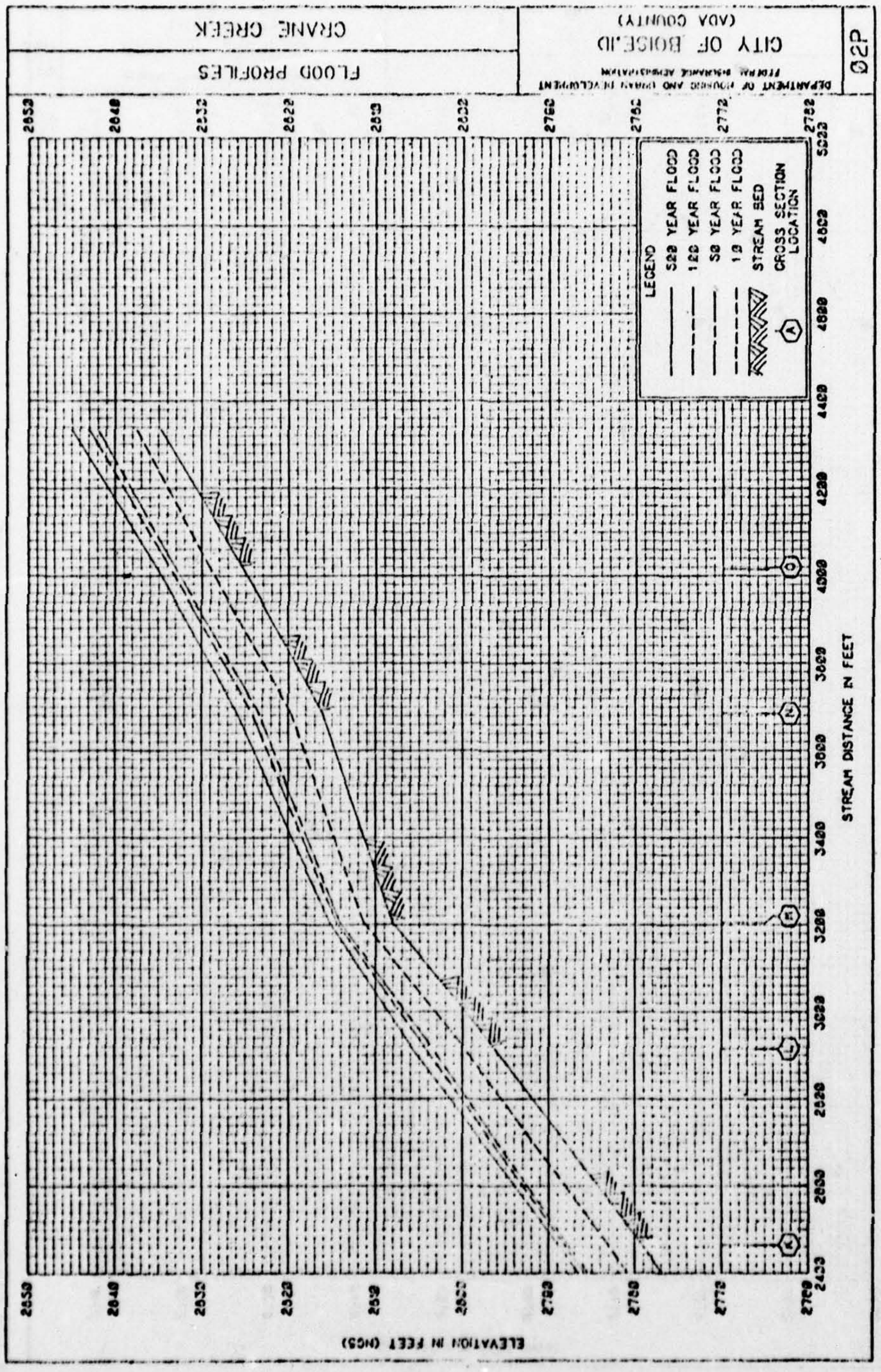


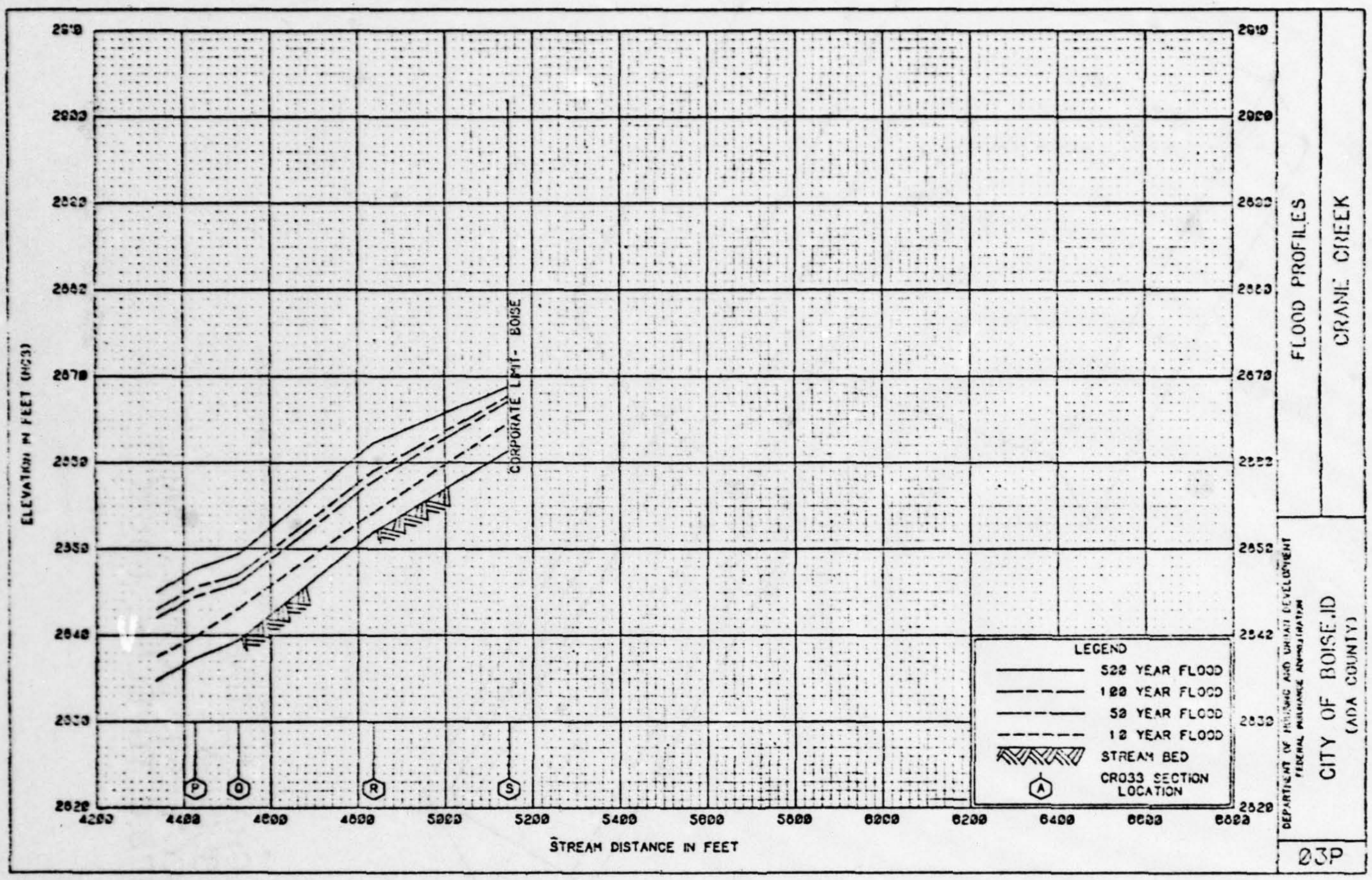
Exhibit 2, 2 of 2



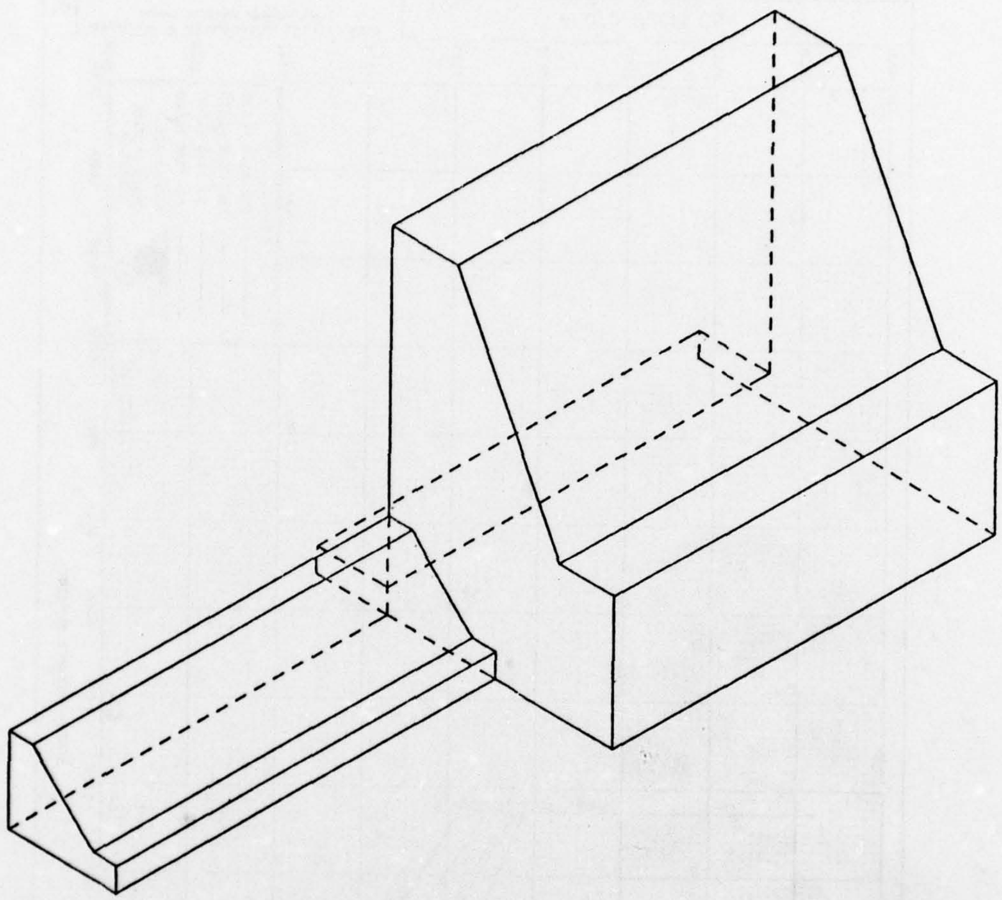
PLOT 1 EXHIBIT 1



PLOT 2, EXHIBIT 1



PLOT 3, EXHIBIT 1



SCALE : 1" = 2Ø'.. ANGLE OF ROTATION = 3Ø DEG.
LOWER GRANITE DAM
CRACK SURVEY
SPILLWAY LEFT TRAINING WALL
ELEV 575.Ø TO ELEV. 646.Ø

Exhibit 3, 1 of 3

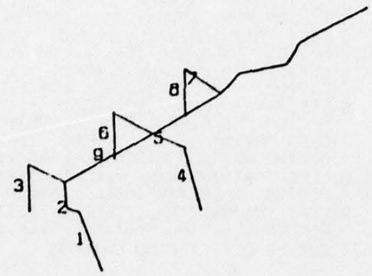


Exhibit 3, 2 of 3

LOWER GRANITE LOCK AND DAM

SHEET 27 ANGLE OF ROTATION- 30. DEG

```
CRACK    1-LEFT TRAINING WALL   , MONO   1, EXTERIOR,
           MEDIUM CRACK, VERTICAL     , SOUTH EXTERIOR   , DRY , NO EFFLORESCENCE VISIBLE,
CRACK    2-LEFT TRAINING WALL   , MONO   1, EXTERIOR,
           MEDIUM CRACK, HORIZONTAL , DECK, DRY , NO EFFLORESCENCE VISIBLE,
CRACK    3-LEFT TRAINING WALL   , MONO   1, EXTERIOR,
           MEDIUM CRACK, VERTICAL     , NORTH EXTERIOR   , DRY , NO EFFLORESCENCE VISIBLE,
CRACK    4-LEFT TRAINING WALL   , MONO   1, EXTERIOR,
           MEDIUM CRACK, VERTICAL     , SOUTH EXTERIOR   , DRY , NO EFFLORESCENCE VISIBLE,
CRACK    5-LEFT TRAINING WALL   , MONO   1, EXTERIOR,
           MEDIUM CRACK, HORIZONTAL , DECK, DRY , NO EFFLORESCENCE VISIBLE,
CRACK    6-LEFT TRAINING WALL   , MONO   1, EXTERIOR,
           MEDIUM CRACK, VERTICAL     , NORTH EXTERIOR   , DRY , NO EFFLORESCENCE VISIBLE,
CRACK    7-LEFT TRAINING WALL   , MONO   1, EXTERIOR,
           MEDIUM CRACK, HORIZONTAL , DECK, DRY , NO EFFLORESCENCE VISIBLE,
CRACK    8-LEFT TRAINING WALL   , MONO   1, EXTERIOR,
           MEDIUM CRACK, VERTICAL     , NORTH EXTERIOR   , DRY , NO EFFLORESCENCE VISIBLE,
CRACK    9-LEFT TRAINING WALL   , MONO   1, EXTERIOR,
           RANDOM CRACKING, MEDIUM   , DECK, DRY , NO EFFLORESCENCE VISIBLE,
* - LATEST SURVEY DETECTED NO CHANGES
```

Exhibit 3, 3 of 3

HEC2

HEC-2 GRAPHICS SESSION

The HEC-2 graphics session was opened by Al Montalvo of the Fort Worth District with a brief talk on the graphics programs that are available throughout the U.S. Army Corps of Engineers. The duplication of effort and the need for a coordinated effort in the production of HEC-2 graphics was covered. A slide presentation of the Fort Worth District HEC-2 graphics program (FP) was presented. A short question and answer session followed in which the audience got a chance to provide additional information as to other HEC-2 graphics programs that are available, but were not covered by the Graphics Users Committee questionnaire. These additional programs were the watersurface profile plot programs from the Walla Walla District and the Huntington District.

Art Pabst from the Hydraulic Engineering Center (HEC) at Davis, California gave a talk on what HEC is presently planning to do about providing HEC-2 graphics. Attached is a brief summary of what HEC is planning to develop dealing with HEC-2 graphics.

[redacted]

<u>HEC-2 Graphical Display Package</u>

The HEC is currently developing a graphical display package in support of the HEC-2, Water Surface Profile Program. The display package will be written in GCS, primarily oriented for, but not limited to, interactive use at a CRT terminal. The user will supply the name of a file containing the results of a previous HEC-2 execution. It is envisioned that the file used will be the archive file containing all input data as well as computed results.

Four types of plots will eventually be available to the engineers. The first will be cross-section plots showing basic geometry and computed water surface elevation. The second will be a pseudo-plan view showing cross-section relationships one to another based on channel and over bank reach lengths. Limits of the flow line will be shown as well as left and right bank stations. This will allow the user to see the variation in water surface top width and general cross-section layout.

The third type of plot will allow several of the variables available in the analysis to be plotted against distance along the river channel. Thus, if computed water surface elevation, energy grade line and thalweg are chosen the traditional profile plot will result. However, an engineer may choose to generate a plot of channel area, percent discharge in the channel, energy slope, or other variable(s) pertinent to the analysis to better understand the flow behavior.

Options will allow the user to see all of, or only portions of the river system in a single plot.

The fourth type of plot envisioned will be special purpose displays of the flow conditions around bridge structures.

As portions of the routines become operational they will be made available for use. Depending on man-power available, it is hoped that initial products will be ready for testing by January 1979.

HEC-2 GRAPHICS

A large number of graphics programs dealing with HEC-2 Water Surface Profiles have been developed throughout the U. S. Army Corps of Engineers. The majority of the programs are similar in purpose and application, but the computer systems and graphics languages used are quite diverse. Ten different Corps offices indicated in the Graphics Colloquium questionnaire that they had developed graphics programs dealing with HEC-2. The respondents indicated in the questionnaires that they used nine different computer systems and six different graphics languages. The equipment used to plot on was also fairly diverse. The only common types of equipment used by the users were the Tektronix terminals and Calcomp plotters.

At first glance it would appear that a great duplication of effort has been expanded throughout the Corps in developing graphics programs that do the same things. This has happened for certain, but the cause is not so much a lack of communication but the diversity in the equipment and software being used throughout the Corps.

It is quite certain that a great need exists in the Corps of Engineers for standardization in software and equipment. A need also exists in dissemination of available graphics programs. The Graphics Colloquim and meetings like it will hopefully solve the problem of the effective dissemination of information.

As mentioned earlier, the HEC-2 graphics programs are all similar. The documentation for the programs is scarce, with only

three of the respondents indicating full documentation for their programs. The Hydrologic Engineering Center at Davis, California, is presently in the process of developing HEC-2 graphics programs and it is my opinion that when their programs are produced that they should become the standard programs as has the HEC-2 backwater program become a standard throughout the Corps of Engineers.

The results of my survey of HEC-2 graphics programs follows. It contains information about the program's capabilities and requirements. It also has the name and telephone number of the person to contact for further details.

HEC-2 PROFILE PLOT PROGRAMS

Organization: ADPC, Philadelphia District
Contact: Carl B. Doughty (597-4790)
Program Name: Backwater Profile Plot - 723 F9-E5080
Computer System: CDC 7600
Graphics Language: Calcomp for Passive Program
Graphics Language: Locally developed software for Interactive Program
Graphics Equipment: Calcomp drum plotter for Passive Program
Graphics Equipment: Tektronix 4014 for Interactive Program

The program is available as either an interactive version or a passive version. The passive version has the following capabilities: Plots up to ten water surface profiles, plots the stream bed flow line, plots bridge symbols, and has the capability of automatically breaking up the profile into multiple plates. The input data comes from the HEC-2 summary output which is stored in a file. The interactive program has similar capabilities with the additional capability of windowing on the plot. Documnentation is available on both programs.

Organization: ORNDP, Nashville, Tennessee
Contact: Wayne Abernathy (852-7138)
Program Name: Plot Elevations vs Cross Sections - 7228330P
Computer System: Univac 1108 CSC - INFONET
Graphics Language: Rplot - An interactive version using Calcomp Calls
Graphics Equipment: Tektronix 4014

This is an interactive profile plot program that has the following capabilities: Plots an unlimited number of water surface profiles, plots the stream bed flow line, plots high water marks, and labels the discharges.

HEC-2 PROFILE PLOT PROGRAMS

Organization: Pittsburgh District, H&H Branch
Contact: Robert W. Schmitt (722-6951)
Program Name: Profile plot for Channels - 7222405P
Computer System: G-225
Graphics Language: Camcomp
Graphics Equipment: Calcomp plotter

This program is a passive profile plot program that has the following capabilities: Plots up to six water surface profiles, plots the stream bed flow line, plots controlling bank, plots bridge symbols, plots labels at a set orientation, and has the option of plotting energy grades or critical depth profiles. The input comes from cards punched by the HEC-2 program and additional user punched cards such as the label and scale cards.

Organization: USAED, Charleston, South Carolina
Contact: Warren R. Bennett (677-4524)
Program Name: HEC-2 Profile Plot Program - 723K221P
Computer System: Honeywell 66/80
Graphics Language: Calcomp
Graphics Equipment: Calcomp plotter

This program is a passive profile plot program that has the following capabilities: Plots an unlimited number of water surface profiles, plots stream bed flow line, plots left and right controlling banks, plots bridge symbols, plots labels at 90 degree orientation, plots energy grade line as option, labels critical depths with an "*", plots cross section numbers as option, automatically breaks up the profile plot into multiple plates, and plots hexagons for section labels. This program is ideal for FIA insurance type profile plots. The input to this program comes from the HEC-2 backwater output and from a user generated labels or instructions file. The documentation is incomplete.

HEC-2 PROFILE PLOT PROGRAMS (CONTINUED)

Organization: Memphis District
Contact: Sam Turner (222-3134)
Program Name: FPCONT
Computer System: Honeywell 66/40,66/80, and G635
Graphics Language: Calcomp
Graphics Equipment: Calcomp plotter

This program is a passive profile plot program that has the following capabilities: Plots up to ten water surface profiles, plots the streambed flow line, plots bridge symbol, and plots labels at a 90 degree orientation based on a station location.

Organization: SPF-ADP, San Francisco Division
Contact: Clyde Okazake (556-0620)
Program Name: HEC-2 Plot
Computer System: G-437
Graphics Language: Calcomp
Graphics Equipment: Calcomp plotter

This program is a passive profile plot program that has the following capabilities: Plots the streambed flow line, plots controlling banks, and bridge symbols. The impact for this program is the HEC-2 input deck. It should be noted that this program is mostly used as an edit check of the HEC-2 input data. This program is also used to plot cross sections. Documentation is available.

HEC-2 PROFILE PLOT PROGRAMS (CONTINUED)

Organization: FPMS, Fort Worth District
Contact: Al Montalvo (334-3207)
Program Name: FTWORTH (Passive) and GCSFTW (Interactive)
Computer Systems: Honeywell 66/80 and G635
Graphics Language: Calcomp and GCS
Graphics Equipment: Calcomp Plotter, Tektronix 4662 Plotter and Tektronix 4014

These two programs are almost identical with the only major difference being that one is interactive and the other is passive. The following capabilities apply to both programs: Plots up to ten water surface profiles, plots the streambed flow line, plots bridge symbole, plots labels at any location, orientation and character size, plots labels at 90 degrees and a set character size based on a station location and the program automatically adjusts label location so that no label overlaps will occur, breaks profile into plates based on user input, and has the option of producing a one-inch by one inch grid. The input is from the HEC-2 backwater output and a labels file. A program called CP is also available which is used to correct the HEC-2 output file.

Organization: FPMS, Fort Worth District
Contact: Al Montalvo (33403207)
Program Name: FP
Graphics Language: GCS
Graphics Equipment: Tektronix 4014 and 4662 plotter

This program is an interactive program which has the following capabilities: Plots up to ten water surface profiles, plots the streambed

HEC-2 PROFILE PLOT PROGRAMS (CONTINUED)

<u>Organization:</u> FPMS, Fort Worth District
<u>Program Name:</u> FP (Continued)

flow line, controlling bank, plots bridge symbole, plots energy grade line, plots critical depth profile, plots a "C" if the water surface is equal to critical depth, has windowing capabilities using the cross hairs, plots both subcritical and supercritical profile, plots based on either channel reach lengths or section numbers, and has an option of plotting the profile at a set scale by automatically breaking up the profile into plates. Most of the capabilities mentioned are optional and can be turned on or off.

HEC-2 CROSS SECTION PLOT PROGRAMS

Organization: ADPC, Philadelphia District
Contact: Carl B. Doughty (597-4790)
Program Name: River Basin Plot (723 F9E 5040)
Computer System: CDC 7600
Graphics Language: Calcomp for Passive Program
Graphics Language: Locally developed software for Interactive Program
Graphics Equipment: Calcomp Plotter (Passive), Tektronix 4014 (Interactive)

The program is available both as an interactive and/or passive version. The passive version has the following capabilities: plots the GR card coordinates and adjusts them based on X1 card parameters (PXSECR and PXSECE), labels the left and right channel stations, plots BT card coordinates and adjusts them based on X2 card parameter (BSQ), and plots the left and right encroachments based on the X3 card. The scales and plot grid labels are adjustable on the passive program. The interactive program has the additional capabilities of windowing on the cross sections by use of the cross hairs and the ability of plotting selected cross sections. Documentation is available on these programs.

Organization: ORNDP, Nashville, Tennessee
Contact: Sam Bradley (582-7138)
Program Name: Preprocessor Plot for HEC-2 Data (7Z28324P)
Computer System: Univac 1108 SCS - Infonet
Graphics Language: R Plot - An Interactive Version using Calcomp Calls
Graphics Language: Calcomp

This program is available as an interactive and passive version. The passive version has the following capabilities: Plots a section label based on T3 card, plots the GR card coordinates and adjusts them based on X1 card parameters (PXSECR and PXSECE), labels the left and right channel stations, plots BT card coordinates, and provides for adding additional

HEC-2 CROSS SECTION PLOT PROGRAMS (CONTINUED)

Organization: ORNDP, Nashville, Tennessee
Program Name: Preprocessor Plot for HEC-2 Data (7228324P)

GR points based on the X4 card. The interactive program has the additional capabilities of windowing on the cross section based on input from the terminal and has the ability of plotting selected cross sections. The interactive program prompts the user for all input and in this way it can be considered to be documented for the user.

Organization: USAED, Charleston, South Carolina
Contact: Warren R. Bennett
Program Name: HEC-2 X-Section Profile Plot (723K 220P)
Computer System: Honeywell 66/80
Graphics Language: Calcomp
Graphics Equipment: Calcomp plotter

The program has the following capabilities: Plots section labels based on title cards and comment cards, plots the GR card coordinates and adjusts them based on X1 card parameters (PXSECR and PXSECE), labels the left and right channel stations, plots the improved channel based on CI card, plots BT card coordinates, and provides additional GR points based on X4 card. In the near future the program will have the capabilities of plotting the water surface based on the HEC-2 backwater.

Organization: Pittsburgh District, H&H Branch
Contact: Robert W. Schmitt (722-6951)
Program Name: G-225
Graphics Language: Calcomp
Graphics Equipment: Calcomp plotter

This program has the following capabilities: Plots the GR card coordinates, labels the cross sections based on the title cards, and plots the BT card coordinates.

HEC-2 CROSS SECTION PLOT PROGRAMS (CONTINUED)

Organization: Wilmington District
Contact: Larry Mitchell (671-4843)
Program Name: Backwater Cross Section Plot
Computer System: Harris 120
Graphics Language: Plot 10 and Calcomp
Graphics Equipment: Tektronix 4014 and Calcomp Plotter

The program is available both as an interactive and passive version. The passive version has the following capabilities: Plots the GR card coordinates and adjusts them based on X1 card parameters (PXSECR and PXSECE), labels the left and right channel stations, plots the artificial levees based on the X3 card, plots the BT card coordinates, and uses the title cards to label the cross sections. The interactive version has the added capability of windowing using the cross hairs.

Organization: Waterways Experimental Station
Contact: Robert Garner (542-3655)
Program Name: HEC-2 Section Plot
Computer System: G 635
Graphics Language: GCS
Graphics Equipment: Tektronix 4014, Tektronix 4662, and Calcomp Plotter

This program has the following capabilities: Plots labels for left and right channel stations, can select cross sections to be plotted, windowing based on cross hairs, and in the near future will have graphics editing capabilities of the input data by use of the cross hairs.

HEC-2 CROSS SECTION PLOT PROGRAMS (CONTINUED)

Organization: Army Engineering District, Norfolk, Virginia
Contact: Wesley Fager or Ralph Moses (924-3621)
Project Name: Passive Plot of Backwater Cross Sections
Computer System: 7600 CDC
Graphics Language: Calcomp
Graphics Equipment: Calcomp Plotter

The program has the following capabilities: Plots section labels based on comment cards and title cards, plots the top of road and low cord based on the X2 card, plots BT card coordinates, plots GR card coordinates and provides for adding additional GR points based on the X4 card. This program has documentation available.

Organization: SPD-ADP, San Francisco Division
Contact: Clyde Okazake (556-0620)
Program Name: HEC-2 Plot
Computer System: G-437
Graphics Language: Calcomp
Graphics Equipment: Calcomp Plotter

This program has the following capabilities: Plots section labels based on title cards, plots left and right channel labels, plots an improved channel based on the CI card, plots the left and right encroachments based on the X3 card, plots the BT card coordinates, plots the GR card coordinates and provides for additional GR points by use of the X4 card. This program is also used to plot streambed flow line profiles. Documentation is available for this program.

HEC-2 CROSS SECTION PLOT PROGRAMS (CONTINUED)

Organization: FPMS Branch, Fort Worth District
Contact: Al Montalvo (334-3207)
Program Name: FP
Computer System: 66/80 Honeywell
Graphics Language: GCS
Graphics Equipment: Tektronix 4014 and 4662 Plotter

This program has the following capabilities: Labels the cross sections based on the comment cards and an input label, plots encroachments based on output from HEC-2, plots the bridge trapezoid and pier width based on the SB card, plots left and right channel stations, adjusts the GR card coordinates based on X1 card parameters (PXSECR and PXSECE), plots the improved channel based on the CI card, plots the top of road and low cord for normal bridges based on the X2 card, plots the BT card coordinates and adjusts them based on the X2 card variable (BSQ), plots all of the X3 card encroachment options, provides for additional GR points by use of the X4 card, has several gridding options, has windowing based on cross hairs, windowing based on highest water surface, plots all or selected water surfaces, and has the option of plotting selected cross sections. All plot grids are based on an inch or a fraction of an inch which is a whole multiple of an inch. Most of the capabilities mentioned are optional and can be turned on or off.

USERS INSTRUCTIONS
ON GRAPHICS
PROGRAM
FP

GRAPHICS PROGRAM
FP

This users instruction paper is designed for the engineer who is well versant in the use of the HEC2 Backwater Program and knows how to use the Macon, Georgia Civil Service Computer. The program is designed to be a graphical display of input and output HEC2 data and is being used to check or edit the input and output of HEC2.

Program FP is composed of two graphics routines. The two routines are the cross-section and water surface profile plotting programs. The input for this program comes from the input for HEC2 and the output temporary files (09 and 10) produced by the timesharing program FHEC2.

Appendix A contains a step by step example on how to execute the cross-section plotting routine. Appendix B has a step by step example showing how to execute the watersurface profile plotting routine. Appendix C covers an example showing how to run the timesharing program FHEC2.

Several of the different plotting options are included in the examples and it is hoped that they are sufficient to get a user started in using the plotting program effectively.

For additional information concerning this program or for a copy of the source programs call FTS 334-3207,3209 and ask for Al Montalvo or Bill Black.

APPENDIX
A

The following is a step by step run of FP Cross-section routine.

Step 1. Give the run command to start execution of the program.

```
RUN 11SU10NXX/FP,E
```

Step 2. The program requests the speed of communication between terminal and computer

```
F
ENTER SPEED - 30 OR 120
=120
```

Step 3. The program requests to know which program is to be executed.

```
HEC2 GRAPHICS PACKAGE

ENTER 0-SECTION PLOT OR 1-PROFILE PLOT
=0
```

Step 4. The program requests the file names of the HEC2 input data and the watersurface output file (file 09) from the HEC2 run. The program will accept the file name "no" for the watersurface output file if none is to be used. The machine number should either be a 2(for Tektronix hard copy) or a 3(for Tektronix 4662 plotter). The machine number is used to set the scale factor so that copies made on the hard copy or plotter will be in inches.

```
HEC2 SECTION PLOT PROGRAM

ENTER HEC2 DATA FILE  -  REQUIRED
ENTER WATER SURFACE FILE & MACHINE # - OPTIONAL
=20EMAR. 25AMAR.0 2
```

Step 5. The program next requests to know which plotting options are to be used. A carriage return as input will cause the program to use only default options. A large negative code outside the range of the legal codes will cause the program to list the legal or permissable codes. A positive code is used to start the plotting at a cross section number greater or equal to the positive code. A positive code or a carriage return will get the user out of the "ENTER CODE= " part of the program. The options are turned on or off depending on what code you enter. To turn on an option enter the negative code for it and than to turn it off, enter the negative code again. The program may be changed at any time by entering an A when cross hairs appear and entering the appropriate code or codes.

```
ENTER CODES
*-99
```

```
ERROR - ILLEGAL CODE ENTERED
```

```
LEGAL CODES
0        CONTINUE PLOTTING
+#       CONTINUE PLOTTING AND PLOT SECTION #
-1       TYPE OF GRID: *SOLID, DASH LINE
-2       WINDOW OPTION: ON, *OFF
-3       PLOT ONLY BRIDGE: ON, *OFF
-4       CHANGE X AND Y SCALES
-5       WATER SURFACE ELEVATIONS TO BE PLOTTED
-6       CHANGE MACHINE #
-7       X AND Y TICK OPTION
-8       TITLE LINE
-9       WATER SURFACE LINES: *SOLID, TICKED
-10      HALF SCALE OPTION: ON, *OFF
-11      ENCROACHMENT OPTION: ON, *OFF
-12      MULTI-PLOT OPTION: ON, *OFF
-13      QUICK PLOT OPTION: ON, *OFF
-14      DISC OPTION: ON, *OFF
-15      1 5 SCALE OPTION: ON, *OFF
-16      AUTO COPY: *ON, OFF
-17      CALIBRATE HARD COPY MACHINE
-18      BRIDGE BT SHADING: ON, *OFF
-19      ENCROACHMENT SHADE: ON, *OFF
ENTER CODES
*
```

Step 6. The program requests a title to label the cross-sections.

```
ENTER TITLE
*MARIES CREEK FIA STUDY
```

Step 7. The program plots the first cross section and cross hairs appear. The cross hairs can be used for many things depending on the character entered. The following is a list of the permissable characters which may be entered. A few examples follow.

ALLOWED CROSS HAIR CHARACTER ENTRIES

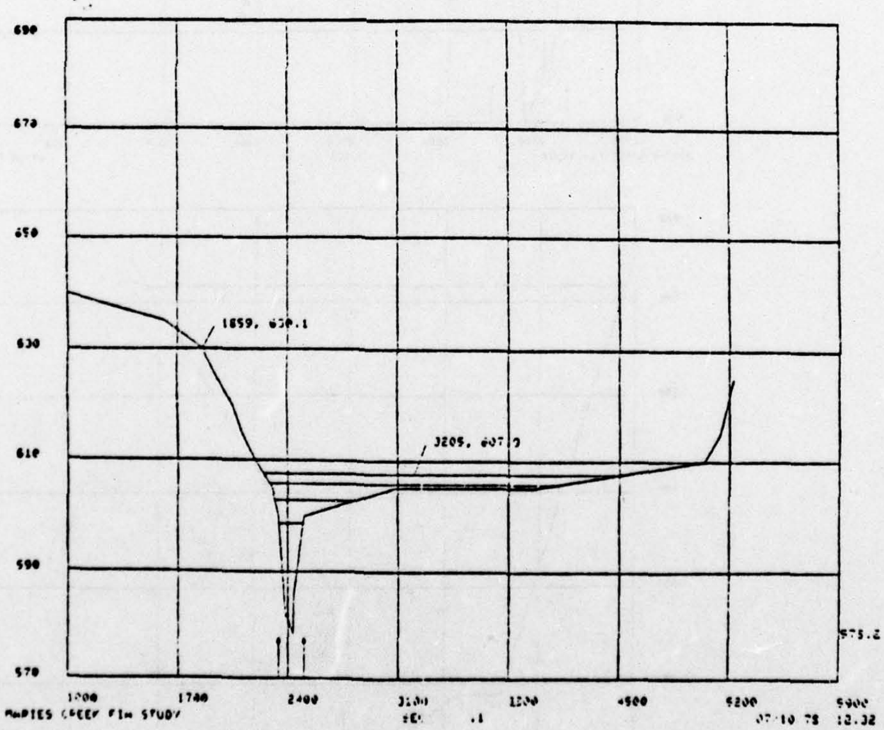
```
K  -   SKIP THE FOLLOWING NUMBER OF SECTIONS
V  -   PRINT THE ELEVATION & STATION OF CROSS HAIR LOCATION
        A SECOND V WILL CAUSE THE COORDINATES TO BE PRINTED
P  -   ONLY AFTER V - PLOT SOLID LINE TO PRESENT LOCATION OF CROSS HAIRS
C  -   CALL YOUPLOT SUBROUTINE FOR MANUAL PLOTTING
        ENTER A B TO EXIT FROM YOUPLOT
A  -   CALL ORDEN SUBROUTINE TO CHANGE PLOTTING OPTIONS OR SPECIFY SECTIC
B  -   ENTER A NEW INPUT SET OF DATA FOR PLOTTING
S  -   STOP PROGRAM AND RETURN TO MAIN
W  -   WINDOW ON SECTION BASED ON LOCATION OF VERTICAL CROSS HAIRS
X  -   ONLY AFTER W - WINDOW BASED ON CHANNEL STATIONS
R  -   REPLOT SECTION
```

The following is a list of permissable characters to be used when using the drafting GCS subroutine UDRIN.

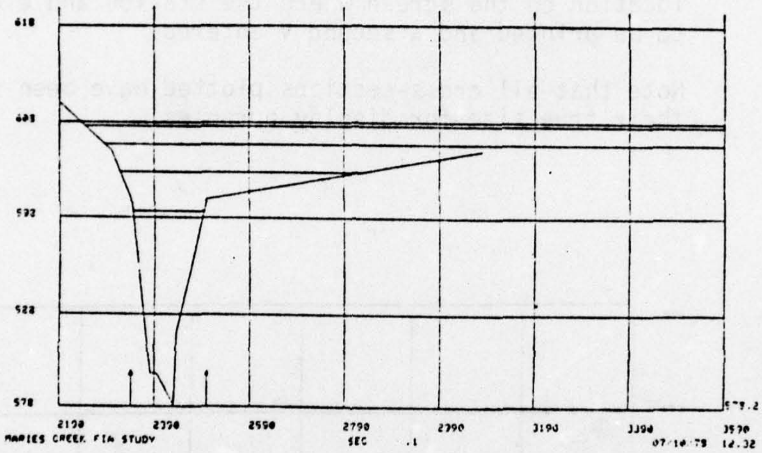
```
SUBROUTINE YOUPLOT ALLOWS THE USER TO DO PLOTTING AND
PRINTING BY USE OF THE CROSS HAIRS AND GCS SUBROUTINE UDRIN
    ALLOWED CROSS HAIR CHARACTER ENTRIES

  B    CAUSES YOU TO EXIT FROM SUBROUTINE YOUPLOT
  A    DRAWS AN ARROW FROM CURRENT BEAM LOCATION TO CURSOR LOCATION
  C    OUTPUTS THE CURRENT SYSTEM CHARACTER AT THE CURRENT CURSOR LOCATION
  D    DRAWS A DOUBLE ARROW FROM CURRENT BEAM LOCATION TO CURSOR POSITION
  E    ERASES THE SCREEN
  H    SETS GRAPHIC STATUS AREA TO HARDWARE CHARACTER TYPE
  K    SETS THE SYSTEM CHARACTER TO THAT CHARACTER ENTERED AT NEXT
        APPEARANCE OF CURSORS
  L    DRAWS A LINE FROM CURRENT BEAM POSITION TO CURSOR POSITION
  M    MOVES THE BEAM INVISIBLY TO THE CURSOR POSITION
  P    PLOTS A POINT AT CURSOR POSITION
  S    SETS GRAPHICS STATUS AREA TO SOFTWARE CHARACTER TYPE
  T    DRAWS A TICKED LINE FROM CURRENT BEAM LOCATION TO CURSOR POSITION
  X    PRINTS COORDINATES AT CURSOR POSITION IN INCHES
  Z    DRAWS A DASHED LINE ACCORDING TO THE CURRENT DASH
        SPECIFICATION FROM THE CURRENT BEAM POSITION TO CURSOR POSITION
```

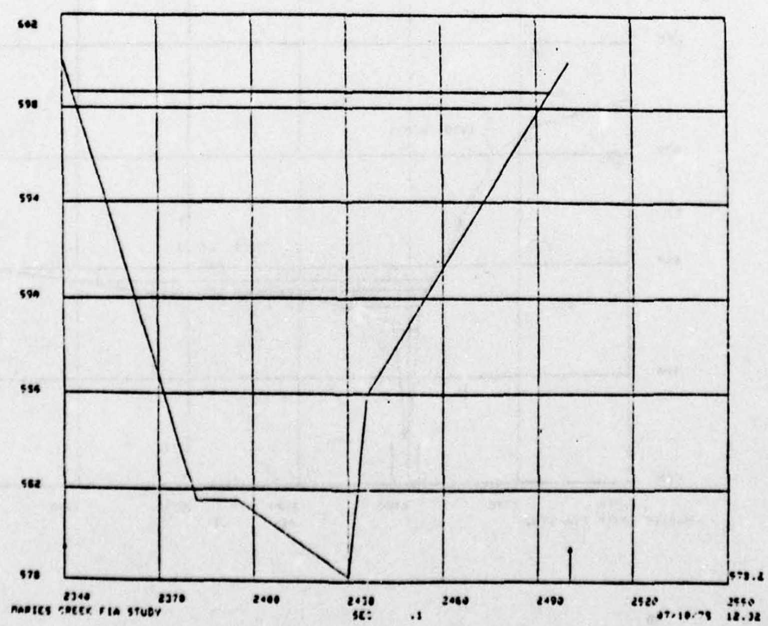
Example 1. The character V is used to label the elevation station based on the cross hairs. The procedure is to position the cross hairs at the location on the plot where the x and y coordinate values are desired and entering a V and carriage return, cross hairs appear again and then are moved to a location on the screen where the station and elevation are to be printed and a second V entered.

Note that all cross-sections plotted have been reduced from their true size for display purposes.

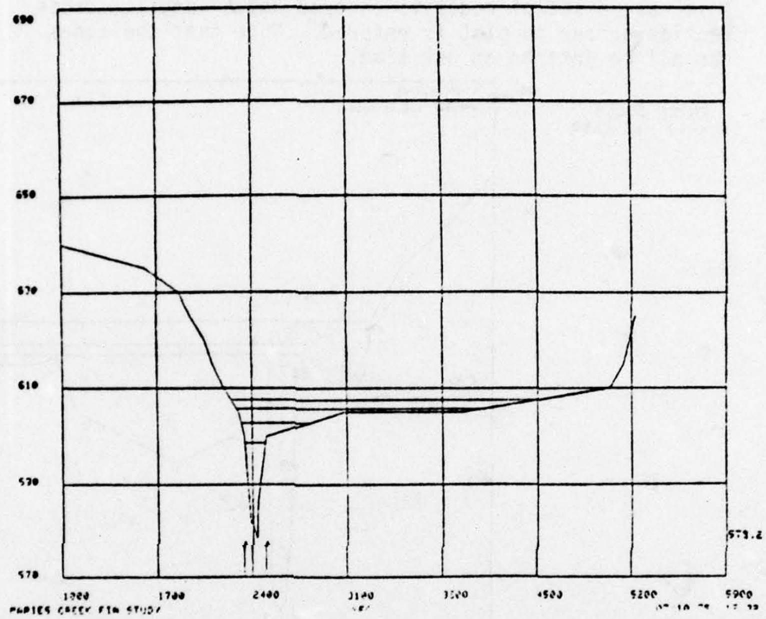


Example 2. The windowing option is executed by placing the cross hairs at the left x location boundary and entering a W and carriage return; cross hairs appear again and are then moved to the right x location boundary and another W entered. The cross-section is reploted and plotting is limited to the left and right boundary locations. If an X is entered instead of a W on the second cross hairs, the windowing will be based on the left and right channel stations.

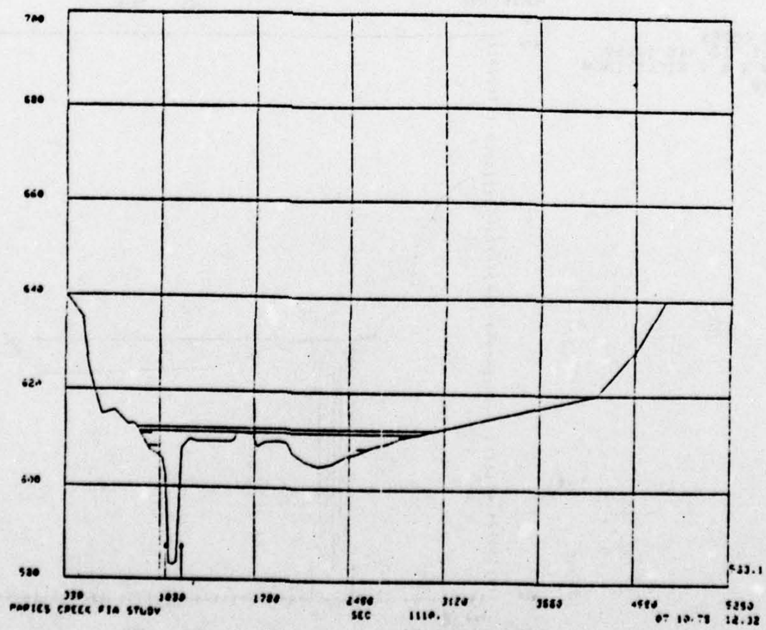




Example 3. An R is entered and the cross-section is reploted in full.

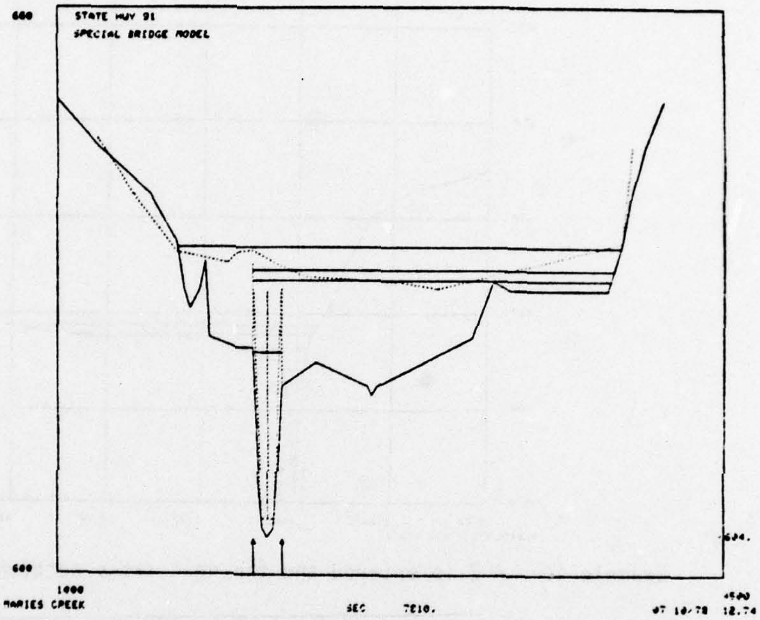


Example 4. A Z is entered and the next cross-section is plotted.

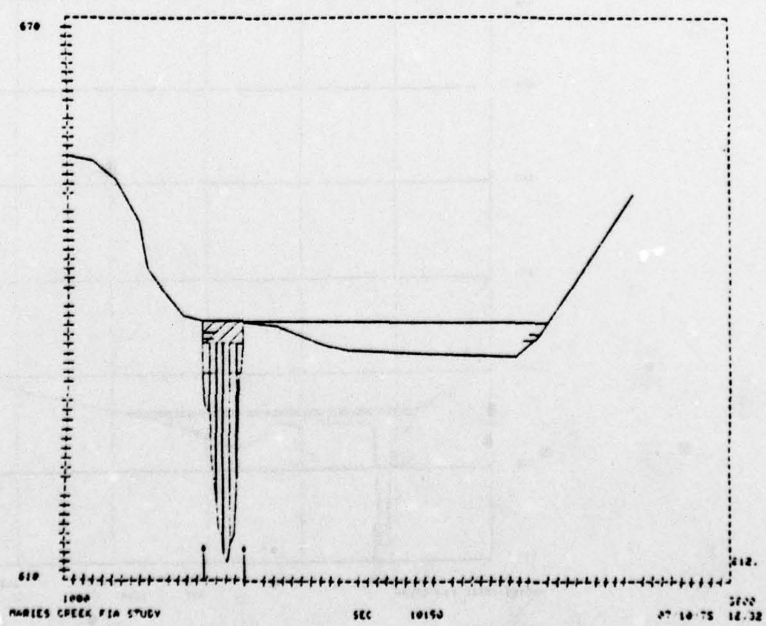


Example 5. An A is entered and you are requested for codes. In this case a set of codes is entered and a specific cross section number to plot is entered. Note that the codes can all be entered at one time.

```
ENTER CODES
*-13 -18 7810
```

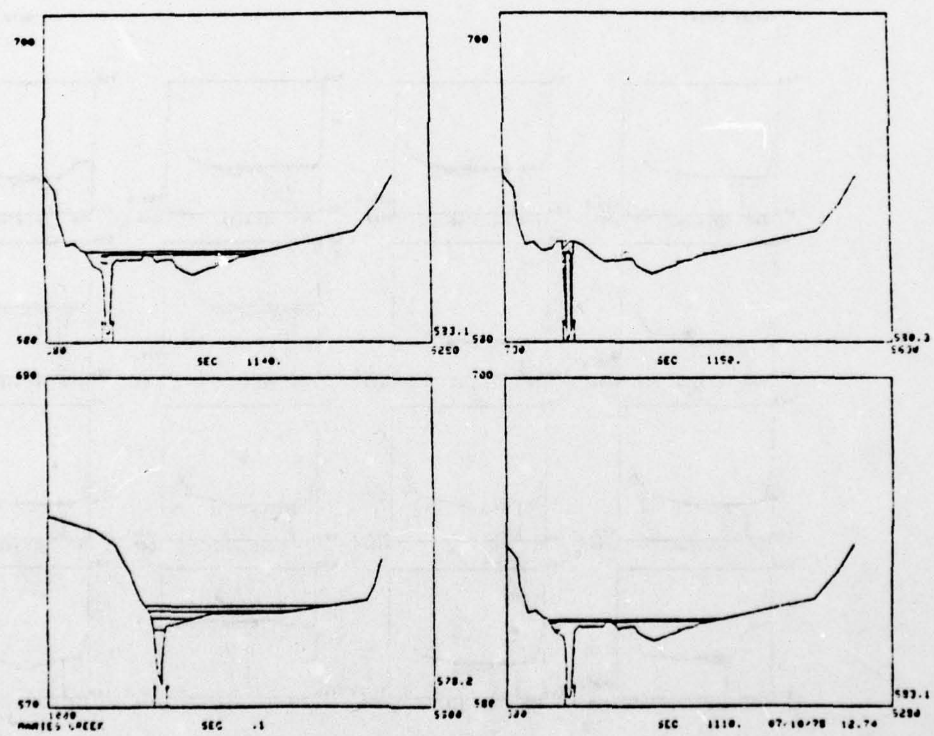



```
ENTER CODES
*-1 -7 -13 -18 10150
ENTER X & Y TICKS/INCH
*10 10
```



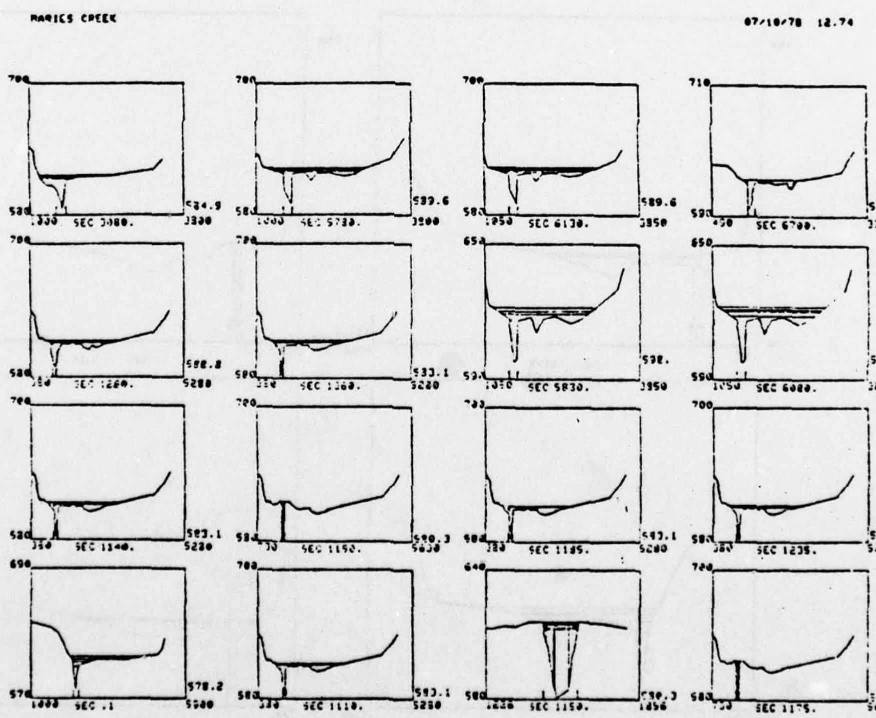
Example 6. An A is entered and you are again requested for codes. The following example shows the option of using four cross-sections per frame. It should be noted that all options apply for the four section option as they do for the one section per frame.

ENTER CODES
*-10 .1



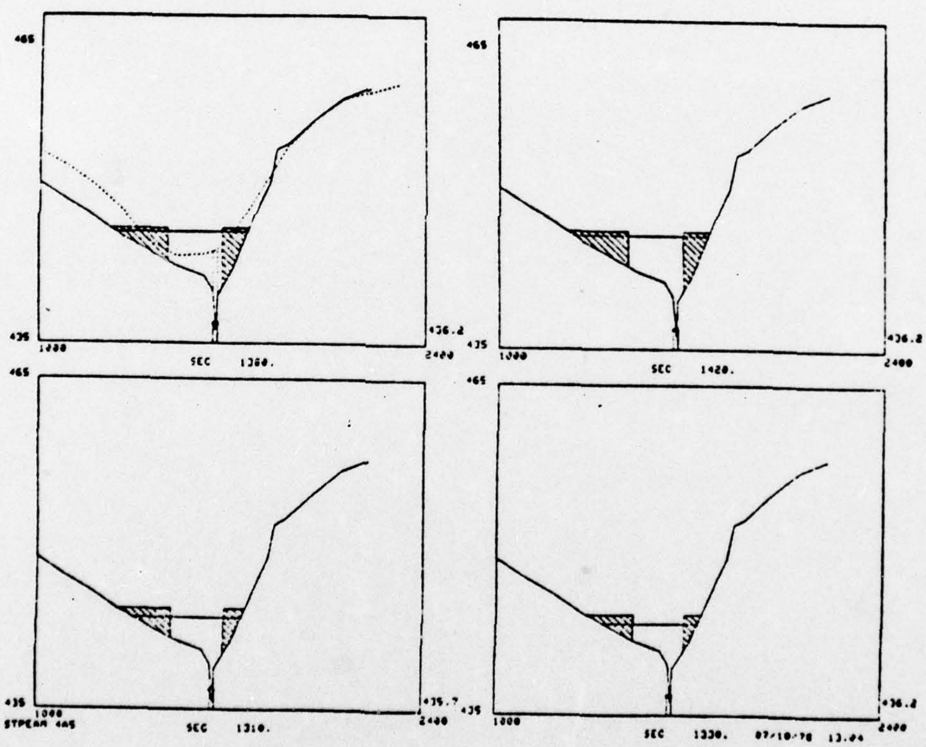
Example 7. An A is entered and you are again requested for codes. The following example shows the option of using sixteen cross-sections per frame.

ENTER CODES
*-15 .1



Example 8. This example is of a seperate run with different input data and the reason it is included in this writeup is to show the shading option when applied to encroachments.

```
ENTER CODES
*-10 -13 -12 -11 -18 -19
```



APPENDIX
B

[redacted]

The following is a step by step run of FP Watersurface Profile routine.

Step 1. Give the run command to start execution of the program.

```
RUN 11SU10NXX/FP,E
```

Step 2. The program requests the speed of communication between terminal and computer

```
F
ENTER SPEED - 30 OR 120
•120
```

Step 3. The program requests to know which program is to be executed.

```
            HEC2 GRAPHICS PACKAGE

   ENTER 0-SECTION PLOT OR 1-PROFILE PLOT
=1
```

Step 4. The program requests the file name of the HEC2 backwater profile output file (FHEC2 temp. file 10), the x-scale, y-scale, and the machine number. The x and y scales should be entered in feet per inch. The machine number should either be a 2(for Tektronix hard copy) or a 3(for Tektronix 4662 plotter). The machine number is used to set the scale factor so that copies made on the hard copy machine or plotter will be in inches.

```
   HEC2 PROFILE PLOT PROGRAM
INPUT FILE NAME
XSCALE AND YSCALE
MACHINE #
•25AMR0AR. 1000 10 2
```

Step 5. The program next requests a label to be used on all the profile plots. This label is usually the name of the creek.

```
ENTER TITLE
•MARIES CREEK
```

Step 6. The program next requests to know which plotting options are to be used. A carriage return as input will cause the program to use only default options. A large positive code outside the range of legal codes will cause the program to list the legal or permissable codes. A negative code or a carriage return will cause the program to exit from the "ENTER CODE=" section of the program. The program options may be changed by entering an A when the cross hairs appear.

```
ENTER CODES
*99

ERROR - ILLEGAL CODE ENTERED

LEGAL CODES
1         TURN ON AUTOMATIC PROFILE BREAKUP INTO PLATE OPTION
2         *TURN OFF AUTOMATIC PROFILE BREAKUP INTO PLATE OPTION
3         *PLOT A SOLID LINE GRID
4         DO NOT PLOT A GRID
5         NEW X AND Y SCALES
6         *PLOT CONTROLLING BANK
7         DO NOT PLOT CONTROLLING BANK
8         CHANGE MACHINE #
9         PLOT CRITICAL DEPTH
10        PLOT EG
11        PLOT WATER SURFACE
12        PLOT EG AND WATER SURFACE
13        PLOT EG AND CRITICAL DEPTH
14        ENTER A NEW DATA FILE
15        SELECT PROFILES TO BE PLOTTED
16        PLOT EG, WATER SURFACE, AND CRITICAL DEPTH
17        DO NOT PLOT WS*CRIT
18        *PLOT ALL WS
19        CHANGE INR VALUE
20        AUTO COPY AND DISC OPTION: ON,  *OFF
21        USE CHANNEL REACH LENGTHS FOR STATIONING: ON, *OFF
22        CALIBRATE HARD COPY MACHINE
ENTER CODES
*
```

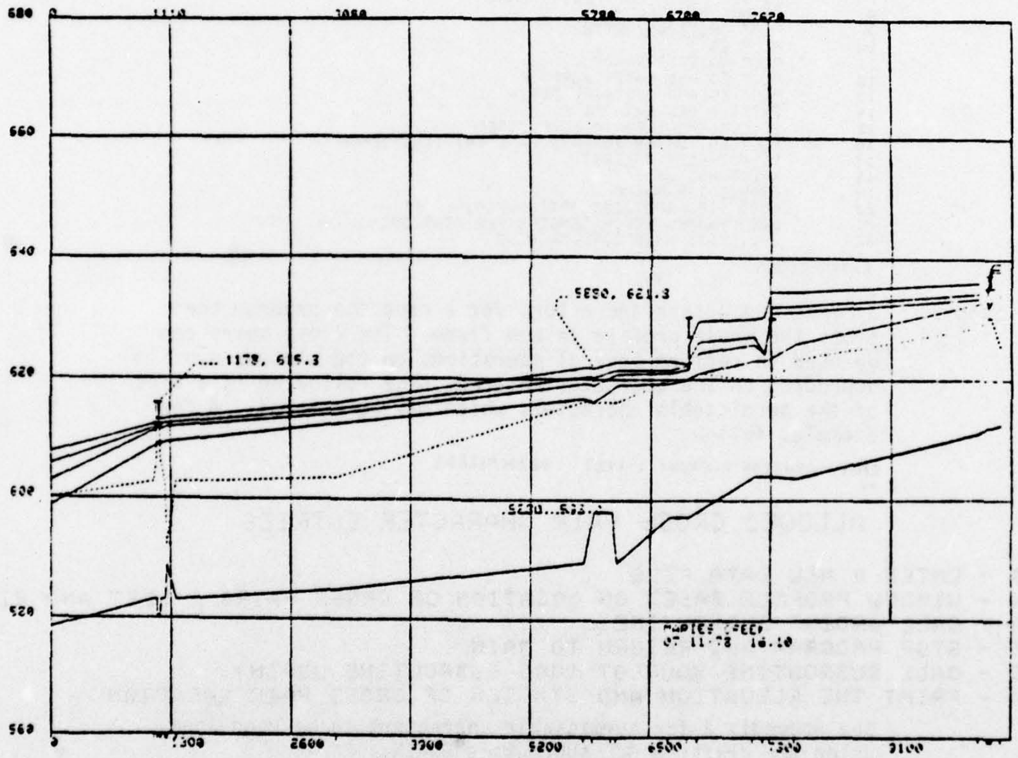
Step 7. By entering a carriage return for a code the program then plots the whole profile on one frame. The cross hairs can be used to perform several operations on the plotted profile depending on the character entered. The following is a list of the permissable characters which may be entered. A few examples follow.

```
ENTER STATION FACTOR: 1(FEET)  5280(MILES)
*1

ALLOWED CROSS HAIR CHARACTER ENTRIES

B - ENTER A NEW DATA FILE
W - WINDOW PROFILE BASED ON LOCATION OF CROSS HAIRS - LEFT AND RIGHT
A - CALL ORDENP SUBROUTINE
S - STOP PROGRAM AND RETURN TO MAIN
C - CALL SUBROUTINE YOUPLOT (GCS SUBROUTINE UDRIN)
V - PRINT THE ELEVATION AND STATION OF CROSS HAIR LOCATION
```

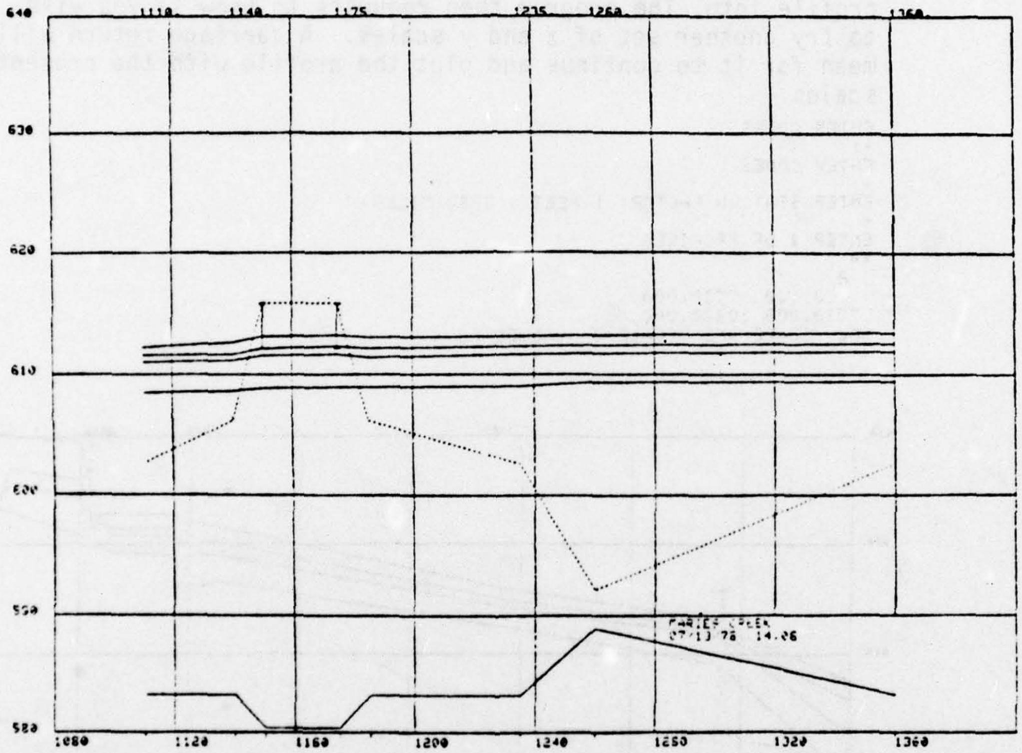
See Appendix A for permissable characters to be used when using the drafting GCS subroutine UDRIN.

Example 1. The character V is used to label the elevation station based on the cross hairs. The procedure is to position the cross hairs at the location on the plot shere the x and y coordinate values are desired and entering a V and carriage return, cross hairs appear again and then are moved to a location on the screen where the station and elevation are to be printed and second V entered.

Note that all profiles plotted have been reduced from their true size for display purposes.

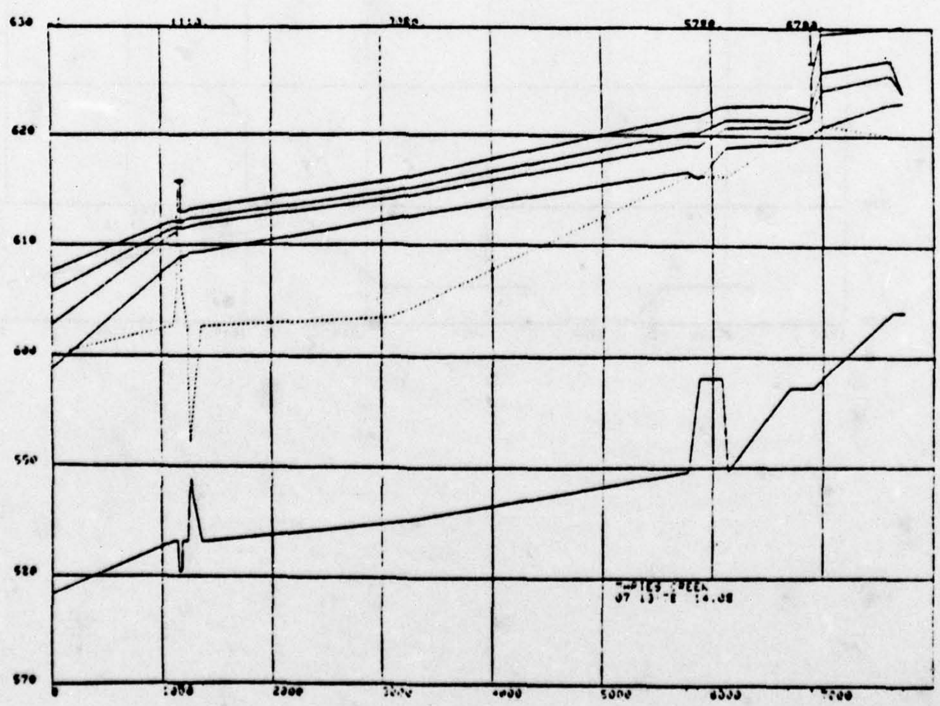


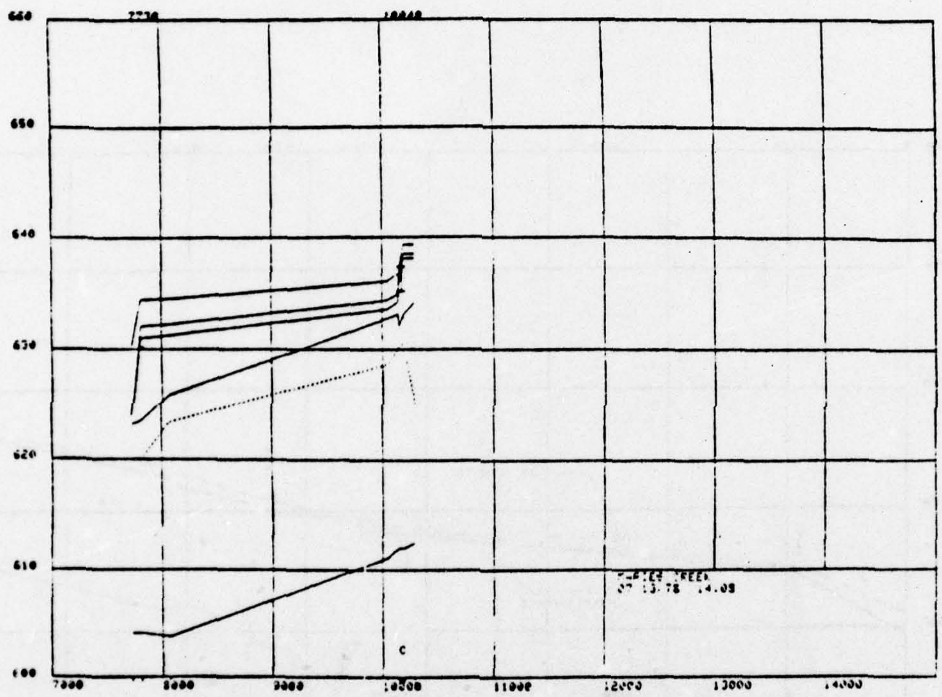
Example 2. The windowing option is executed by placing the cross hairs at the left x location boundary and entering a W and carriage return, cross hairs appear again and are then moved to the right x location boundary and another W entered. The watersurface profile is replotted and plotting is limited tothe left and right boundary locations.



Example 3. An A is entered and you are requested for codes. In this case the option to breakup the profile into plates is entered. By using this option the x and y scales that you entered at the begining of the program are used. A carriage return is entered for the second request for codes and than the program requests to know if your stationing input is in feet or miles. A carriage return for this question will mean feet. The program then requests to know the profile number which has the highest watersurface elevation. The program then gives you the number of plates that it will require to breakup the profile into. The program then requests to know if you wish to try another set of x and y scales. A carriage return will mean for it to continue and plot the profile with the present scales.

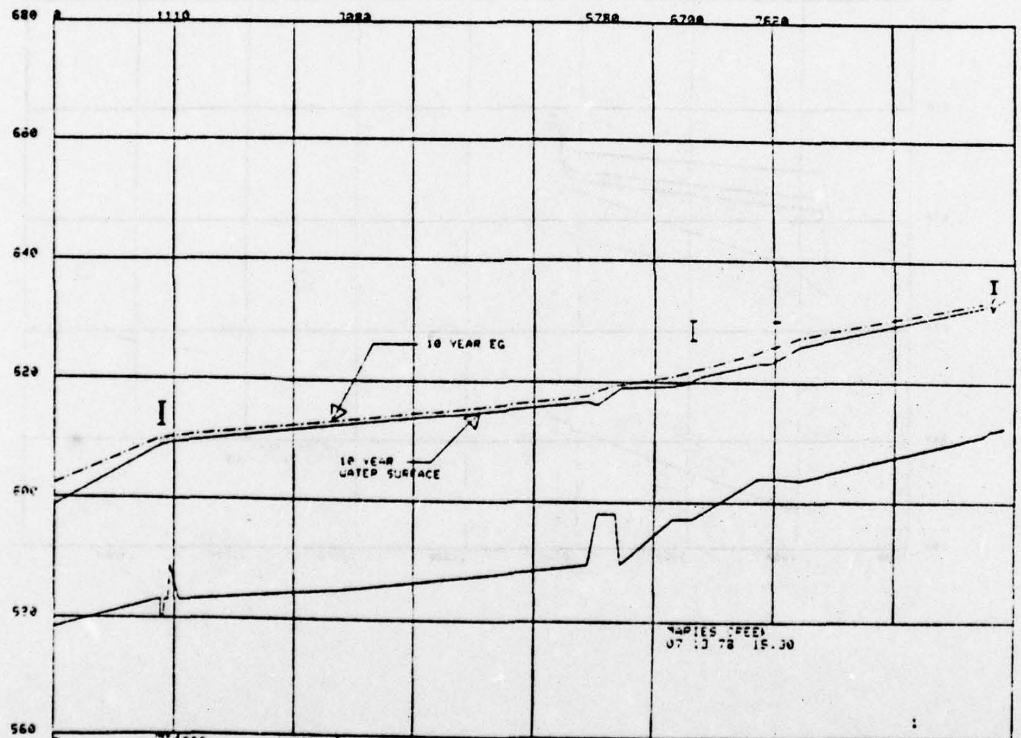
```
ENTER CODES
*1
ENTER CODES
*
ENTER STATION FACTOR: 1(FEET)  5280(MILES)
*
ENTER # OF PROFILES
*4
  2
    0.100  7730.000
 7730.000 10290.000
NEW XSCALE AND YSCALE 0  VALUES NO
*
```




660
650
640
630
620
610
600
7730
10040
7000
8000
9000
10000
11000
12000
13000
14000
C
07 13 78 14.09

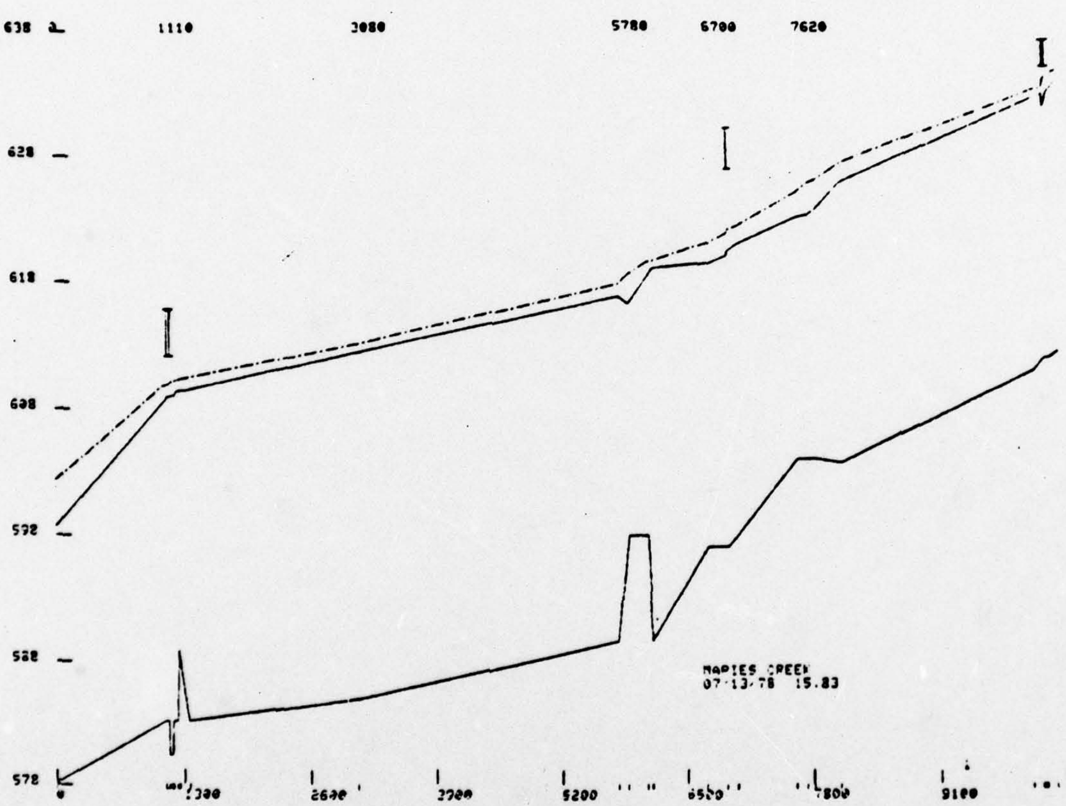
Example 4. An A is entered and you are requested for codes. Several options are demonstrated in this example including the use of the drafting GCS routine UDRIN. The program plots each profile seperately when ever the EG or Critical Depth are being plotted with the Watersurface profile.

```
ENTER CODES
*7 4 12
ENTER CODES
*
ENTER STATION FACTOR: 1(FEET) 5280(MILES)
*
```



Example 5. This example shows the use of the option of removing the plotted grid.

```
ENTER CODES
*7 12 4
ENTER CODES
*
ENTER STATION FACTOR: 1(FEET)  5280(MILES)
*
```



APPENDIX
C

Pro

...veral respects.

are available on the

and creates several ou

input. The only additi

that the timesharing file

line numbers

What follows is a step by ste

Step 1. The first step is to
command.

```
RUN ISU10NXX/FHEC2,E
```

Step 2. The program requests th
and several output para
or output files. The fo
required for a regular ba

```
ENTER: FILE NAME. IPCODE(0,...
NEP(1...), IN004(0-NO,1-YES
*20BMAR.

***** PROFILE.

***** PROFILE NO

***** PROFILE NO

***** PROFILE NO  4 .
SUMMARY ON FILE 03
ADDITIONAL PRINTOUT ON FILES 09 AND 10
WEIR INCREMENT FLOW DATA ON FILE 30
REGULAR PRINTOUT ON FILE 04
*OLD 09
*RESEX 1000,1
*SAVE 26AMAR.0
DATA SAVED-26AMAR.0
*OLD 10
*RESEX 1000,1
*SAVE 25AMAR.0
DATA SAVED-25AMAR.0
```

TABLE OF INPUT PARAMETERS

Variable	Value	Description
IPCODE	0	No special options requested
	1	Used to activate the generation of the FIA floodway data table (temp. file 02).
	2	Used to activate the generation of the zone data (file 02) which is used by program FMEAN.
	3	Used to activate the generation of the storage data (file 10) which is used as input by program ST.
NOP	0	Use the BT card encroachment option.
	1	Do not use the BT encroachment option.
NEP	1-15	Profile number which a weir trace is to be stored (file 31) for later use as input for program BTENC.
IN004	0	Do not suppress regular printout file 04.
	1	Suppress the regular printout file 04.

USERS INSTRUCTIONS
ON GRAPHICS
PROGRAM
FTWORTH & GCSFTW

GRAPHICS PROGRAM
FTWORTH

Program FTWORTH is designed to plot HEC2 backwater profiles. The program is a passive graphics program witten in Calcomp software and the output plots are plotted on a Calcomp drum plotter. The program requires two files for input. These files are a labels or instructions file and a watersurface profile file (temporary file 10). The computer system presently being used is the CSC 66/80 at Macon, Georgia. It should be noted that an interactive version of program FTWORTH is also available which is used to preview the profile plots on a Tektronix 4014 or 4662 plotter. The name of this program is GCSFTW. A program call CP is also available which is used to correct the HEC2 watersurface profile file.

Appendix A contains an explanation of the input requirements for program FTWORTH and a step by step example. Appendix B contains a step by step example of program GCSFTW. Appendix C contains an explanation of the input requirements for program CP and an example of the input.

This users guide is written primarily for the Forth Worth District. For users outside the District, additional instructions are required which are not covered in this guide.

For additional information concerning this programs call FTS 334-3207 and ask for Al Montalvo or Bill Black.

APPENDIX
A

The following is an explanation of the input for program FTWORTH's labels or instructions file. It should be noted that it is required that a four digit line number be used on all lines of input. The labels that are to be plotted are read starting at the sixth character location.

The first line of input contains the following variables.

Variable	Value	Description
LIN	+	This is a four digit line number.
XSCL1	+	X-scale in feet per inch.(1000 default)
YSCL1	+	Y-scale in feet per inch.(10 default)
XIXNS	+	Minimum x value to be used to set the axis.
	-1	The program will determine the minimum x value. (-1 default)
IYNS	+	Minimum y value to be used to set the axis.
	-1	The program will determine the minimum y value. (-1 default)
NST	+	Number of plates to breakup the profile into. (1 default)
FAC	+	Factor used to multiply all x values. (1 default)
ICH	0(default)	Use section numbers for x values.
	1	Use channel reach length for x values.
	+>1	Use channel reach length for x values and use +number as starting x value.
IGRID	0	Do not plot a grid. (use grid paper to plot on)
	1(default)	A grid will be plotted by the program.

The second line of input is only required if the variable NST is greater than 1.

Variable	Value	Description
LIN	+	This is a four digit line number.
SCF(1)	+	Starting x value for first plate.
SCL(1)	+	End x value for first plate.
.		
.		

.
.
.
SCF(NST)

SCL(NST)

The third line of input is used to input a title to be used in the title block. The title is limited to 29 characters.

Variable	Value	Description
LIN	+	This is a four digit line number.
TA(4)		The title label to be used.

The fourth line and so on are used to provide labels for the plot. Two basic labels are available in this program. One of the plot labels is based on only an x location, the program uses a set orientation and character size and the program keeps track of making certain that none of the labels do not overlap or intersect the profiles or bridge symbols. The other label available is one in which the x and y location is specified. The two different labels can be intermixed. Each plot label is composed of two lines of input. The following is a description of each.

The first line is used to specify the location of the label and several other parameters.

Variable	Value	Description
LIN	+	This is a four digit line number.
X1	+	The x location of the label.
Y1	+	The y location of the label.
	-1(default)	The y location of the label will be under the control of the program.
ANG1	+	The angle at which the label will be plotted. (90° default)
SIZ	+	The size of the characters in inches.

The second line is used to input the character label. The label has a character limit of 39 characters.

Variable	Value	Description
LIN	+	This is a four digit line number.
ALAB		This is the character label to be plotted.

The following is an example of an execution of the program by use of the timesharing system CARDIN.

```
SYST CARDIN OLD 11SW10NXX/FTWORTH,R
*EDIT
-RVS:/FILE10/:/254A DEL
RVS:/FILE10/:/25KA451/

20200$:PRMFL:01,R,L,11SW10NXX/25KA451

-RVS:/.FILE/:/31KA451/

20250$:PRMFL:02,R,L,11SW10NXX/31KA451

-RUN
  SNUMB # 1946d
```

The following is a listing of the labels file and a partial listing of the HEC2 output profile file.

```
*OLD 31KA451
*LIST

1000 500 10 0 400 1
1001 STREAM 4A5
1002 0
1003 CONFLUENCE WITH
1004 0
1005 STREAM 4A4 NEAR HUTCHINS
1006 450
1007 SECTION A
1008 1345
1009 GOODE ROAD
1012 1950
1013 SECTION B
1014 2058
1015 EAST FRONTAGE ROAD
1016 2166
1017 IH 45 NORTH BOUND LANE
1018 2255
1019 IH 45 SOUTH BOUND LANE
1020 2363
1021 WEST FRONTAGE ROAD
1022 3020
1023 SECTION C
1024 3820
1025 CHANNEL DAM
1026 3930
1027 SECTION D
1028 3200 418 0 .1
1029 WATER SURFACE PROFILES
1030 3200 416 0 .1
1031 DALLAS COUNTY FIS
1034 3200 414 0 .1
1035 KJC
1036 2050 475 0 .1
1037 ZONE A2
1039 3300 445 0 .1
1040 THALWEG


LIST 25KFB

1000T3
1001S 31100.000999999.0999999.0    531.6    541.0    540.2
1002E      3360.    540.3   540.8    0.        0
1003S 32775.000999999.0999999.0    538.6    552.6    552.0
1004E      3360.    549.4   550.2    0.     1675
1005S 32800.000999999.0999999.0    542.3    544.8    543.7
1006E      3360.    545.7   550.3    0.     1700

                          .
                          .
                          .
                          .
                          .

1031S 35590.000999999.0999999.0    557.0    563.2    565.2
1032E      2330.    562.8   563.5    0.     4545
1033T3
1034S 31100.000999999.0999999.0    531.6    541.0    540.2
1035E      5570.    542.0   542.7    0.        0
1036S 32775.000999999.0999999.0    533.6    552.6    552.0
1037E      5570.    551.5   552.4    0.     1675
1038S 32800.000999999.0999999.0    542.3    544.8    543.7
1039E      5570.    552.1   552.5    0.     1700
1040S 32835.000999999.0999999.0    533.6    540.3    540.7
1041E      5570.    552.1   552.6    0.     1725
```

APPENDIX
B

The following is a step by step example run of the interactive program GCSFTW.

Step 1. Give the run command to start the execution of the program.

```
*GCS2D 11SW10NXX/GCSFTW,E
```

Step 2. The program requests to know the device that is being used.

```
device-TK4
```

Step 3. The program requests to know the speed of transmission.

```
ENTER SPEED 120 OR 30
=120
```

Step 4. The program than requests to know the file name of the watersurface profile file, the name of the labels file, and three additional variables.

```
ENTER FILE10, LABEL FILE, IHALT(1), IGRID(1),IAUTO(1)
=25KA451 31KA451 1 1 1
```

Variable	Value	Description
FILE10		The name of the file under which temporary file 10 is stored.
LABEL FILE		The name of the labels file.
IHALT	0	Do not send a Ctrl S.
	1,2	Send a Ctrl S. Used only when a disc is being used to record the plot.
IGRID	0	Do not plot a grid.
	1	Plot a grid.
IAUTO	0	If the plot doesnt fit on the screen, scale the x and y axis so that it will fit.
	1	Use the given scales to plot the profiles on the screen. If the plot is too big for the screen, the program will abort.

Step 5. Cross hairs will appear at the end of each plot. When a C and carriage return is used the program will start to use the GCS drafting subroutine UDRIN. A character B will cause the program to exit from subroutine UDRIN.

APPENDIX
C

The following is an example of the input requirements for program CP which is used to correct the watersurface profile file. The input for this program requires two input files. The input files are the watersurface profile file and the command file which contains the changes to be made.

The following is a listing of the variables which may be changed and the order that they appear in the watersurface profile file.

Variable	No.	Description
SECNO	1	Section number
ELLC	2	Low Cord elevation
ELTRD	3	Top of bridge or road elevation
ELMIN	4	Minimum streambed elevation
XLBEL	5	Left bank channel elevation
RBEL	6	Right bank channel elevation
Q	7	Discharge
CWSEL	8	Computed watersurface elevation
EG	9	Energy grade line elevation
CRIT	10	Critical watersurface elevation
TCHL	11	Cumulative channel reach length

The following is a description of the four fifferent cards that are used to effect a change in the watersurface file.

Card	Description
S	Section number where the change is desired. (required)
R	Remove section specified on previous S card.
C	Change Variables 1-6 and 11, based on the following: Variable number and value of variable.
E	Change Variables 7-10, based on the following: Profile number, variable number, and value of variable.

The following is an example of a run or execution of program CP.

Step 1. Give the run command to start execution of the program.

```
*RUN 11SU10NXX/FF,E
ENTER PROGRAM NAME
•CP
```

Step 2. The program requests for the file names of the backwater file and the correction file.

```
ENTER FILE 10 AND CORRECTION FILE
•25KA451 30KA451
```

The following is a listing of a command file.

```
090 S 1
095 E 1 8 430.4 2 8 431.0 3 8 431.2 4 8 431.6
100 S 1330
110 R
120 S 1360
130 C 1 1345 2 439.9 3 443.2 4 435.9
140 S 1950
150 R
160 S 2040
170 R
180 S 2075
190 C 1 2058 2 443.9 3 448.3 4 439.4
200 S 2135
210 C 1 2172 2 446.5 3 454.6 4 441.5
215 E 1 8 455.9 2 8 456.8 3 8 456.9 4 8 457.1
220 S 2285
230 C 1 2248 2 447.0 3 454.6 4 442.0
240 S 2345
250 R
260 S 2380
270 C 1 2363 2 447.0 3 450.8 4 442.9
275 S 3770
280 C 1 3825 4 459.5
285 E 1 8 465.4 2 8 465.7 3 8 465.8 4 8 466.2
300 S 4460
310 R
320 S 4660
330 C 1 4460
```

A DATA PRE-PROCESSING SYSTEM FOR ONE-DIMENSIONAL UNSTEADY FLOW MODELING

Introduction

1. Over the past several years the use of one-dimensional (1-D) numeric models for determining backwater curves and the effects of unsteady flow conditions has become well established. Several programs have emerged with wide acceptance within the Corps of Engineers: "Water Surface Profiles" (HEC-2), "Gradually Varied Unsteady Flow Profiles," in the HEC library, "Scour and Deposition in Rivers and Reservoirs" (HEC-6), and "Simulated Open Channel Hydraulics" in the WES library. In addition, the NWS program DWOPER appears to be gaining acceptance as a useful tool for hydrologic analysis with Corps offices. Experience in developing the required input data for these models has demonstrated that this is not an easy task. The volume of information required is quite large and is difficult to process without some means of visualizing the data in a meaningful way. In addition, it is often necessary to reduce the amount of field data used because must of it does not add new information for modeling purposes.

2. Since HEC-2 has been used as a standard hydrologic program for a number of years now, many Corps district offices have standardized the recording of channel cross section data into the format required by HEC-2. Most of the programs involving computations of flows in rivers require basically the same cross section data; however, in different formats and usually with tables of elevation versus hydraulic parameters which can be computed from cross section data. A computer program, "Geometric Elements from Cross Section Coordinates," was developed by the Hydrologic Engineering Center to compute the required parameters for USTFLO using HEC-2 formatted data. This demonstrated the advantage of standardized data collection and recording within the district offices and the use of a translation program to restructure the data as necessary for various modeling work.

3. It has become apparent that combining the data translation program with interactive graphics capabilities would provide substantial improvements in preparing data for such numerical modeling activities. There would be a major savings in time and improvements in the quality of the modeling results. With the increasing volume of work using models of this type, the time savings are very valuable. Use of the GCS and standard FORTRAN will provide a standardized graphics system that will be available to all Corps offices.

System Concept

4. Basically, the preparation of the data for modeling work follows a multi-step procedure. The field survey cross section data are collected and recorded in computer compatible form. This has in many instances been standardized to the format required by HEC-2. These data are then plotted--at the present time, this plotting is often accomplished by manual methods. The data are edited to correct erroneous recordings. Often the field data contain more cross-sectional points than can be accommodated by the model being used and many of these points do not add any useful information. Therefore, some extraneous data may need to be removed. Finally, some additional information may be required such as the edges of the channel. The corrected and reduced data are then converted into the proper format required by the computer model being used in the study. For the HEC-2 and HEC-6 programs, there would be no conversion. For USTFLO and SOCHMJ, the cross section data will be used to compute hydraulic parameters (area, wetted perimeter, top width, etc) with varying water surface elevations. In order to visualize these factors, it is necessary to plot these parameters versus elevation, or versus distance along the stream. Such plots give the analyst valuable insight into potential or observed model responses.

AD-A062 478 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 9/2
GRAPHICS IN THE CORPS. PROCEEDINS OF THE COMPUTER GRAPHICS COLL--ETC(U)
1978 J M JONES, R L HALL, N RADHAKRISHNAN

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5. With these steps in mind, a system of programs is now being designed, developed, and tested by the Mathematical Hydraulics Group. These programs will assist the analyst in editing the cross section data, converting the edited data to the proper program input format, and presenting the general characteristics of the channel data. The first portion of this system is both a batch and an interactive program that creates preview plots for such editing. The second portion of the system is a program that will selectively smooth and reduce the field data to an acceptable set of cross section coordinates for use by the models. The third part of the system will allow interactive insertion and editing of the reduced data set; while the fourth part will convert and reformat the data as required for use in the desired model. Finally, the program will generate graphs of the hydraulic parameters (such as hydraulic radius, surface width, cross sectional area, etc.) as a function of elevation or profiles of these parameters as the analys directs.

Status of System

6. Development of this system was initiated in the second quarter of FY 78. Presently three programs are available. The first program plots cross sections from HEC-2 formatted data. Documentation of this program is contained as Appendix A. This program is available on the WES G 635 and BOEING KIT systems.

7. The second program reduces the complete set of cross section field data to a smooth set of data that is within a tolerance specified by the analyst. It is a batch program and "preliminary" documentation may be obtained upon request. This program is available on the Kirtland AFWL computer system and is being placed on the BOEING KIT and the LBL systems.

8. A program to preview, with windowing capabilities, the smooth data from the second program is now available on the WES G 635 and

BOEING KIT systems. This is an interactive program that will also be made available in the LBL system. Documentation of this program is contained in Appendix B.

Future Plans

9. Plans for the immediate future include combining these first three programs into a single package that will accomplish all functions and to make this available on the WES G 635, BOEING KIT, Kirtland AFWL, and LBL computer systems. This package or system will be more fully documented and tested by other offices.

10. Next the program to plot the hydraulic parameters will be developed, tested, and documented. It is anticipated that this can be accomplished in the next 3 months. Following that a program for interactive correction and replotting of the cross section data will be developed. To complete the system, programs to plot the output from the numeric models could be added to make a complete operating system for all 1-D models.

11. Any comments concerning this future development would be appreciated. It may well be that NWS' DWOPER and some new dam break models should be added to this sytem. Comments should be directed to Larry L. Daggett or William A. Thomas at FTS 542-2259 or 2511, respectively.

Acknowledgments

12. The development of this system is being jointly sponsored by the Computation and Analysis Program and by individual project studies.

APPENDIX A

Cross Section Previewer

ORIGIN OF PROBLEM

This program is a combination of the HEC2 GEDA2 input subroutine combined with a multi-device plot subroutine. This program was written by W. A. Thomas and R. Garner III.

PURPOSE OF PROGRAM

The program was developed in order to do cross section plots of HEC2 data in a quick efficient mode so that the visualization of the data could enhance the development of numerical modeling input for other programs.

DESCRIPTION OF EQUIPMENT

The program was written for use on the Honeywell 635 but may be used with minor modification on other high-speed computers which have Calcomp plot routines as part of their system library. The program can be directed to generate plots on both the CRT device or the high-speed drum plotter, in both cases Calcomp plot routines are incorporated in the process.

DESCRIPTION OF THE PROGRAM

The program is written in standard FORTRAN IV and basically is composed of two parts. An input routine for reading in one section of data at a time, and a plot routine for plotting that section of data.

The input routine (GEDA2) will accept all HEC2 type cards as input, but will use only X1 and GR type cards to get the necessary data for plotting. All other HEC2 type card codes are ignored as input.

The X1 card has the following information; the section number, the

APPENDIX A (continued)

number of Y,X pairs that define the section, the left and right stations of the bank of the channel. It is of the form:

Starting Column	Variable	Format	Description
1	1A	2A1	card identification characters
9	NUMST	F6.1	num. points in section
17	STCHL	F8.0	left bank of channel
25	STCHR	F8.0	right bank of channel

Each X1 card will be followed by a number of GR cards. Each card contains up to 5 pairs of point descriptions. These are of the form Y then X and are formatted 10F8.0.

The program will continue to read through the data, reading then plotting each data set until it encounters an ER type card (column 1 format 2A1). When the ER type card is encountered program wrap up begins and exit is called.

DETERMINING PLOTTING DEVICE

To output the plots to a CRT DEVICE a $ USE CRT control card must be used along with a CALL FACTOR(FT) statement at the beginning of the program. The FT argument may be set to .4 or .5 in order to best fit the output plot onto the CRT screen.

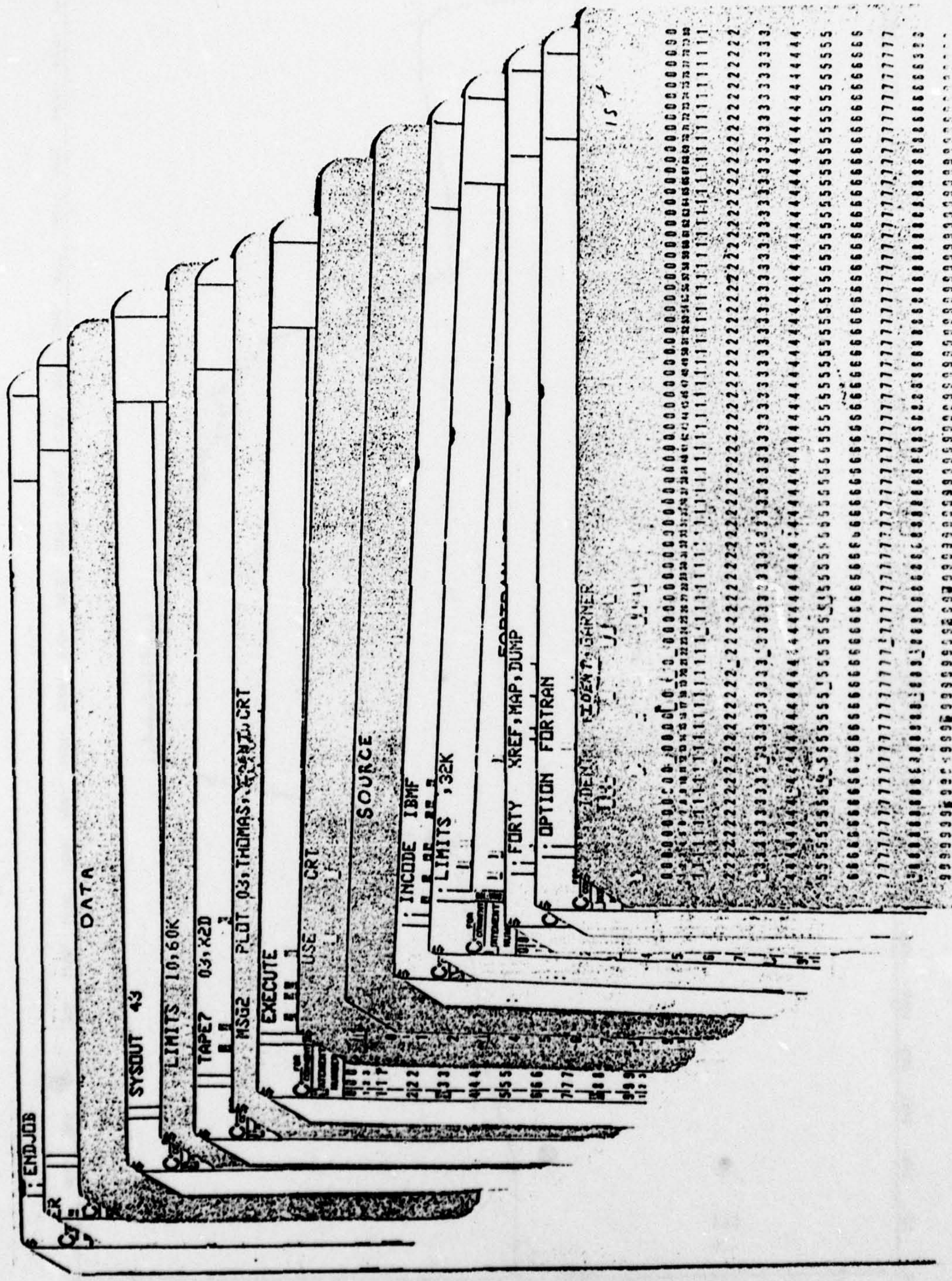
To output the plots to a drum plotter the factor must be set to 1 to get a full drum plot and the $ USE card must designate the proper drum device name. An example set of job control cards is shown in Incl 1.

DESCRIPTION OF PLOTTED OUTPUT

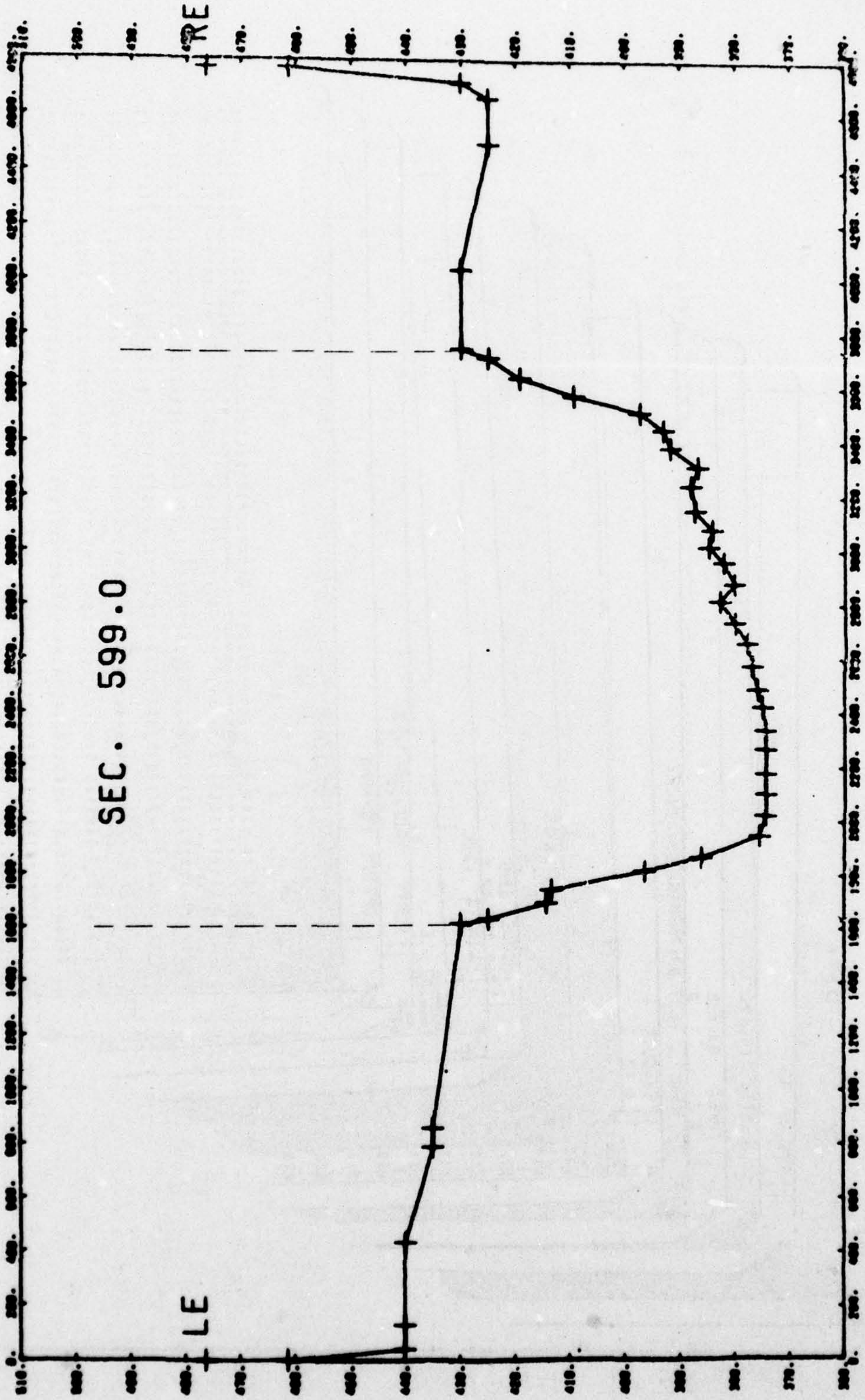
Each cross section is plotted separately and is automatically scaled for maximum size allowed by the device used for plotting. The section is defined by a straight line drawn between data points designated by

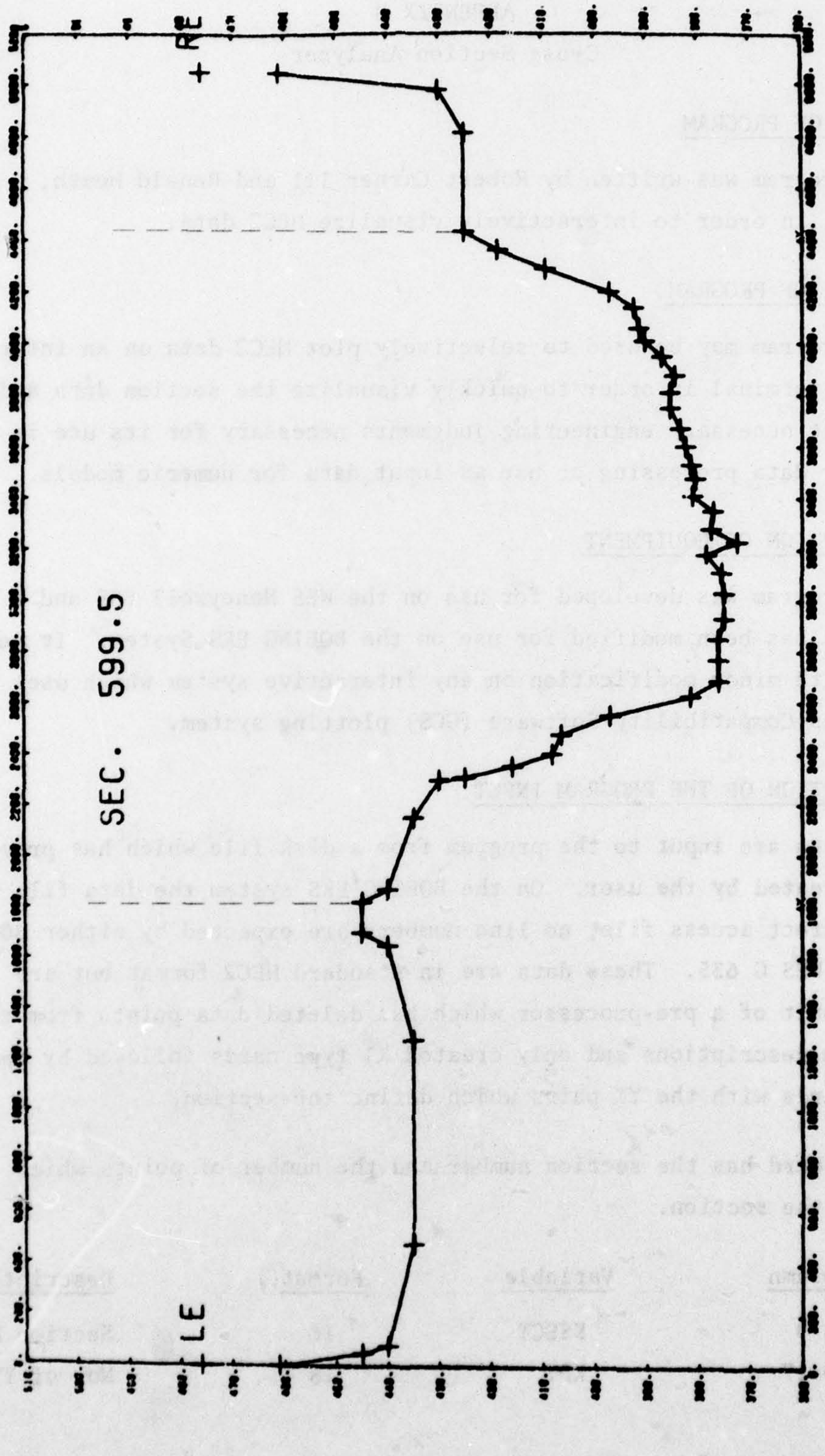
Appendix A (continued)

pluses(+). The left bank of channel is designated by a + and the letters LE, the right bank by a + and the letters RE. The section number is printed on the center of each section plot. Examples of the plotted cross sections are shown in Incls 2 and 3.



$ENDJOB
DATA
SYSOUT 43
LIMITS 10,60K
TAPE7 03,X2D
MSG2
PLOT 03,THOMAS,
CRT
EXECUTE
USE CRT
SOURCE
INCODE IBMF
LIMITS ,32K
FORTY XREF,MAP,DUMP
OPTION FORTRAN
IDENT GARNER


SEC. 599.0
LE
RE



SEC. 599.5
LE
RE

APPENDIX B
Cross Section Analyzer

ORIGIN OF PROGRAM

This program was written by Robert Garner III and Ronald Heath, WESHP3, in order to interactively visualize HEC2 data.

PURPOSE OF PROGRAM

This program may be used to selectively plot HEC2 data on an interactive terminal in order to quickly visualize the section data and make the necessary engineering judgments necessary for its use in further data processing or use as input data for numeric models.

DESCRIPTION OF EQUIPMENT

This program was developed for use on the WES Honeywell 635 and a version has been modified for use on the BOEING EKS System. It may be used with minor modification on any interactive system which uses the Graphics Compatibility Software (GCS) plotting system.

DESCRIPTION OF THE PROGRAM INPUT

HEC2 data are input to the program from a disk file which has previously been created by the user. On the BOEING EKS system the data file must be a direct access file, no line numbers are expected by either BOEING or the WES G 635. These data are in standard HEC2 format but are the result of a pre-processor which has deleted data points from the section descriptions and only created X1 type cards followed by the data cards with the YX pairs which define the section.

The X1 card has the section number and the number of points which define the section.

Column	Variable	Format	Description
4-9	KSECT	I6	Section No.
10-17	KPT	I8	No. of YX pairs

APPENDIX B (continued)

The data pairs are on the cards following the X1 card, there are up to 5 pairs per card, format 10F8.0.

PROGRAM DESCRIPTION

The program is written in standard FORTRAN IV. It reads in pre-processed HEC2 data one section at a time and plots the section on a 4010 series Tektronix or other interactive plotting device. The user designates the data file name, section number to be plotted, format order of points, line type, and axis labels.

The user may window-in on a part of the drawn section by inputting a "w" in response to the first set of cross hairs which appear at the end of each plot. If a "w" is input rather than a "n", then the user may use the cursers to define first the bottom left and then the upper right corner of the window to be plotted. The window definition is set by pressing the RETURN key. After a windowed view has been plotted, the user is again shown the cross hairs to ask if further windowing is wished. A "w" or an "n" may be input, or a "R" may be input to retain the present window dimensions so that the same window may be viewed through successive sections.

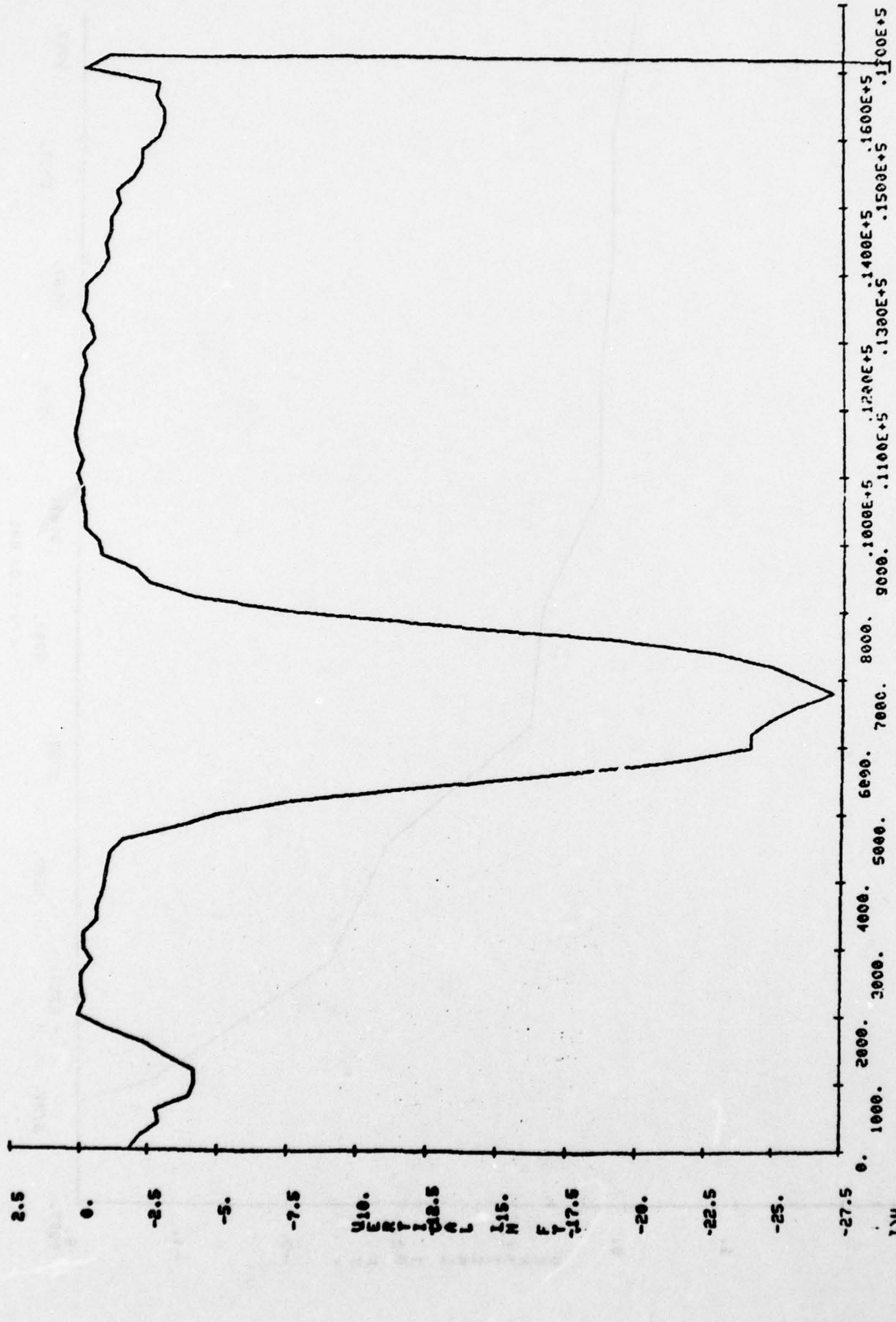
Cross sections must be viewed in the order that they are arranged in the data file, skipping those for which plots are not required. When the user has completed viewing the file, a "000" section request will terminate the run.

RUNNING THE PROGRAM

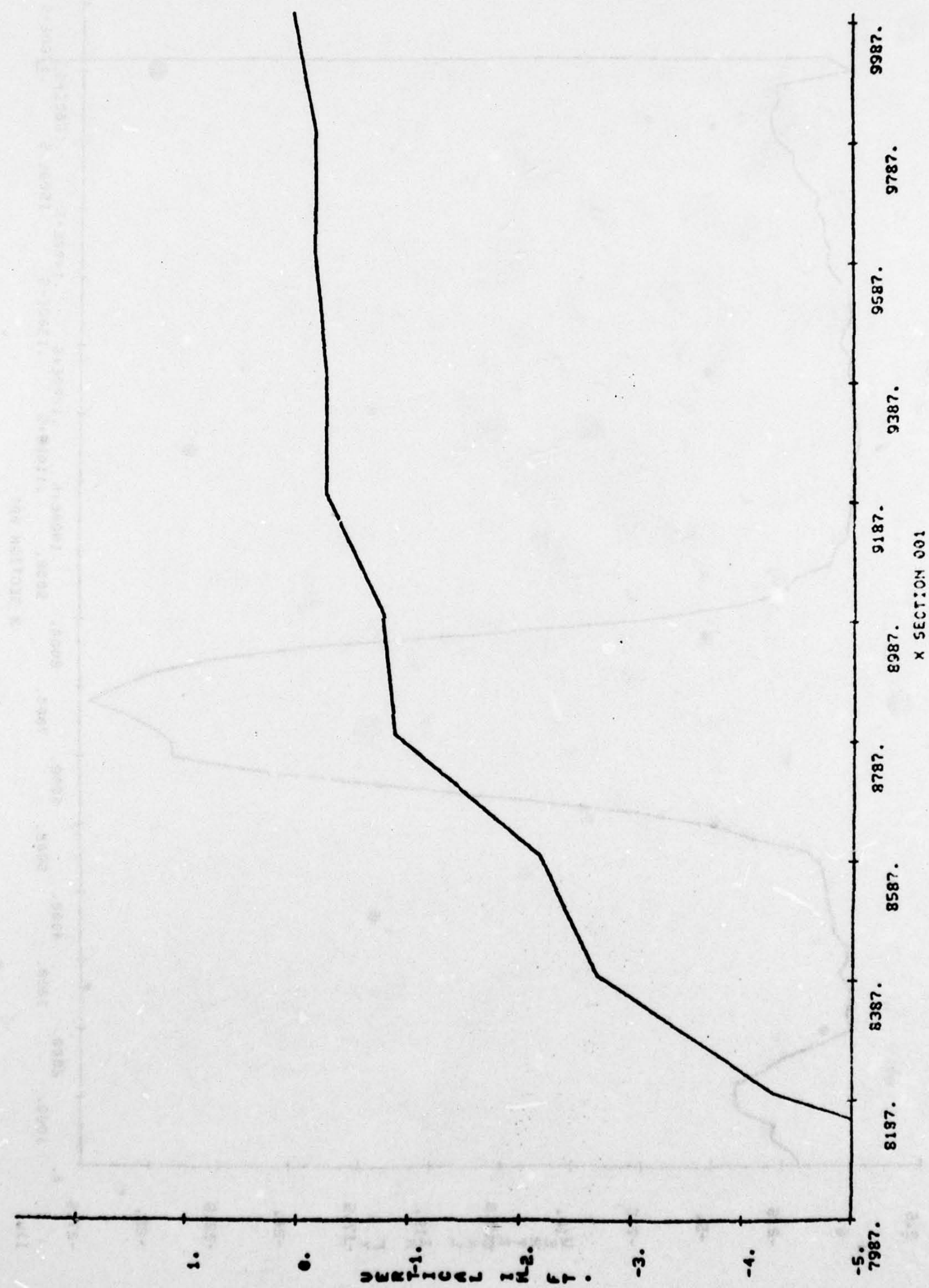
Since the program may be run on the WES G 635 and on BOEING EKS, there are naturally two different methods of execution. The following examples will show the user how to run the program on each system. The first example will show the user how to run the program on each system. The first example is for the BOEING EKS, Incl 1. Inclosure 2 illustrates the operation made for the WES G-635.

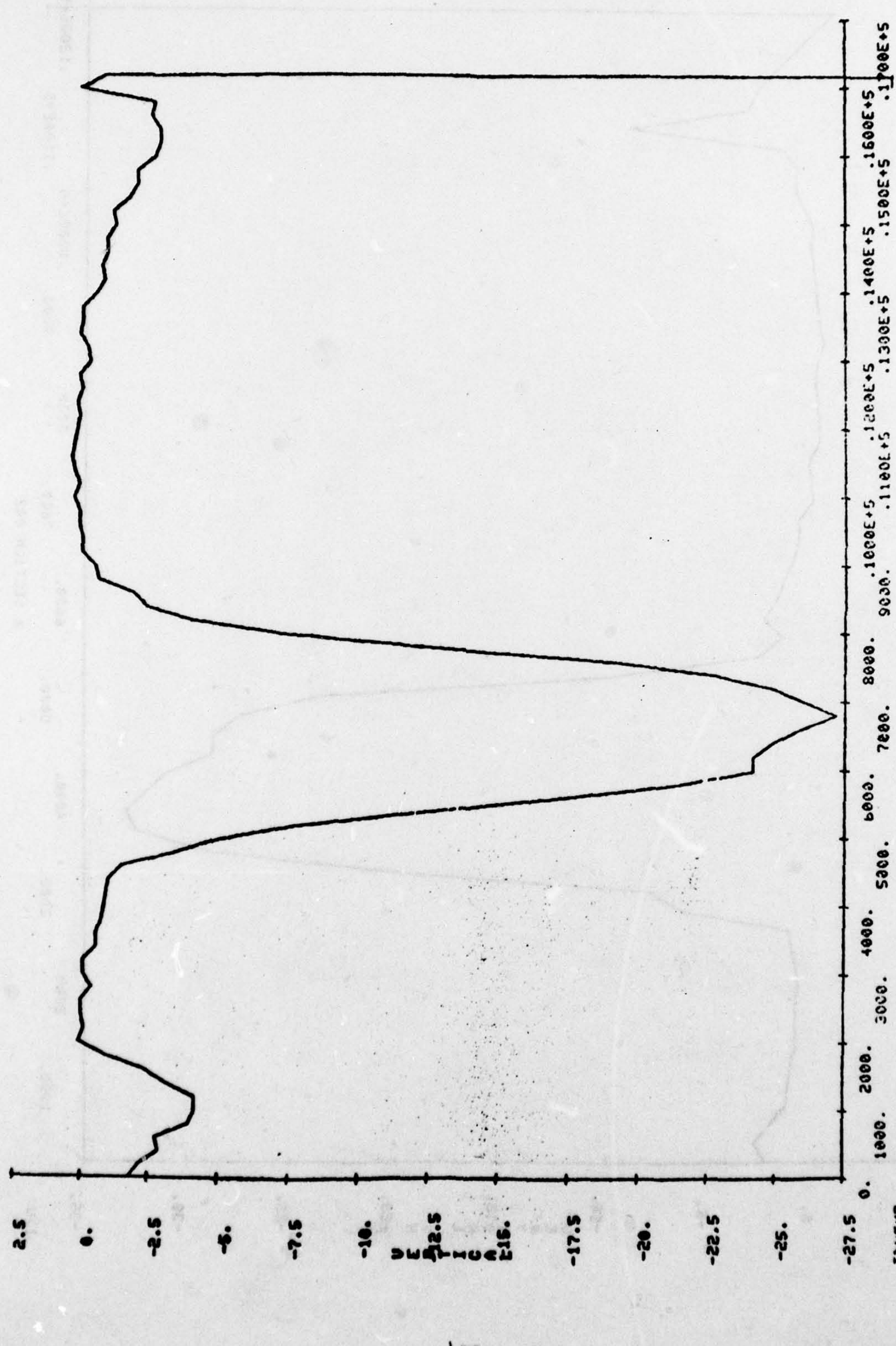
Running on EKS

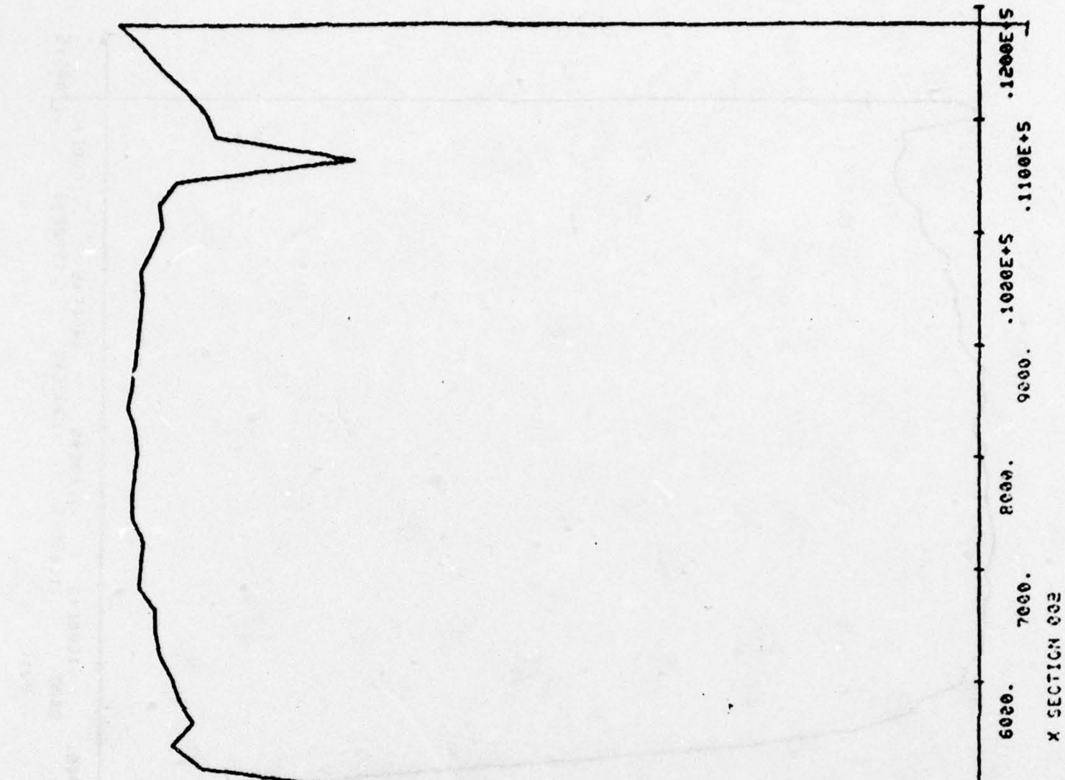
```
BAT
C>FTN,I=T4,B=T40,L=0
       .213 CP SECONDS COMPILATION TIME
C>NULL
N>GET,GCS2D/UN8CECELB

N>CALL,GCS2D(I=T40,DEV=GCSTK4)

 DATA FILE NAME ?
I>DATA
 FIRST VALUE X OR Y ?
I>Y
 INPUT LINE TYPE
I>LINE
 NEXT SECTION (FMT I3)
I>001
       1      82   0.000
 INPUT THE LABEL FOR THE HORIZONTAL AXIS
I>     X SECTION 001\
 INPUT THE LABEL FOR THE VERTICAL AXIS
I>     VERTICAL IN FT.\
```



VERTICAL IN FT
2.5
0.
-2.5
-5.
-7.5
-10.
-12.5
-15.
-17.5
-20.
-22.5
-25.
-27.5
0.
1000.
2000.
3000.
4000.
5000.
6000.
7000.
8000.
9000.
.1000E+5
.1100E+5
.1200E+5
.1300E+5
.1400E+5
.1500E+5
.1600E+5
.1700E+5
X SECTION 001

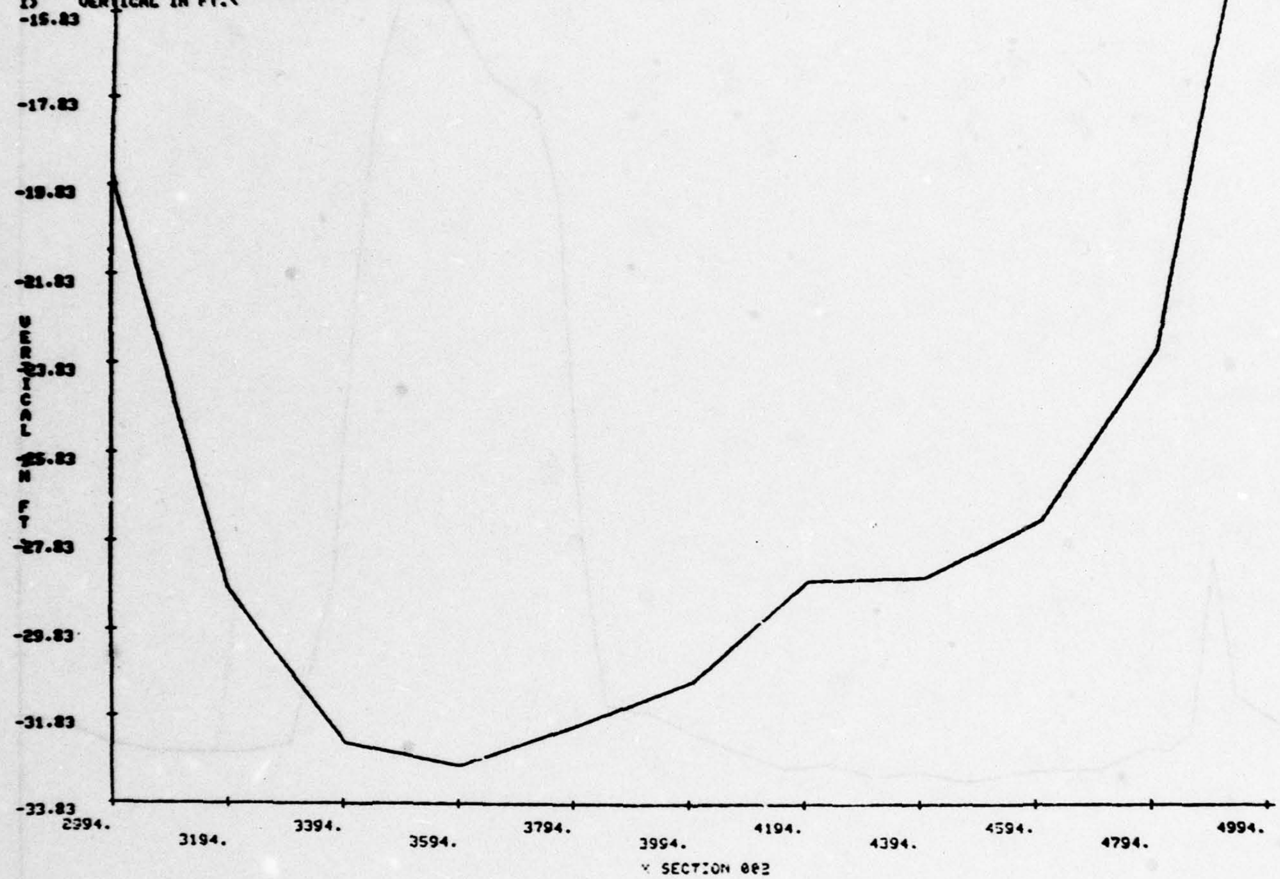

1.
0.
-1.
-3.
-4.
-5.
VERTICAL IN FT.
7987.
8187.
8387.
8587.
8787.
8987.
9187.
9387.
9587.
9787.
9987.
X SECTION 001

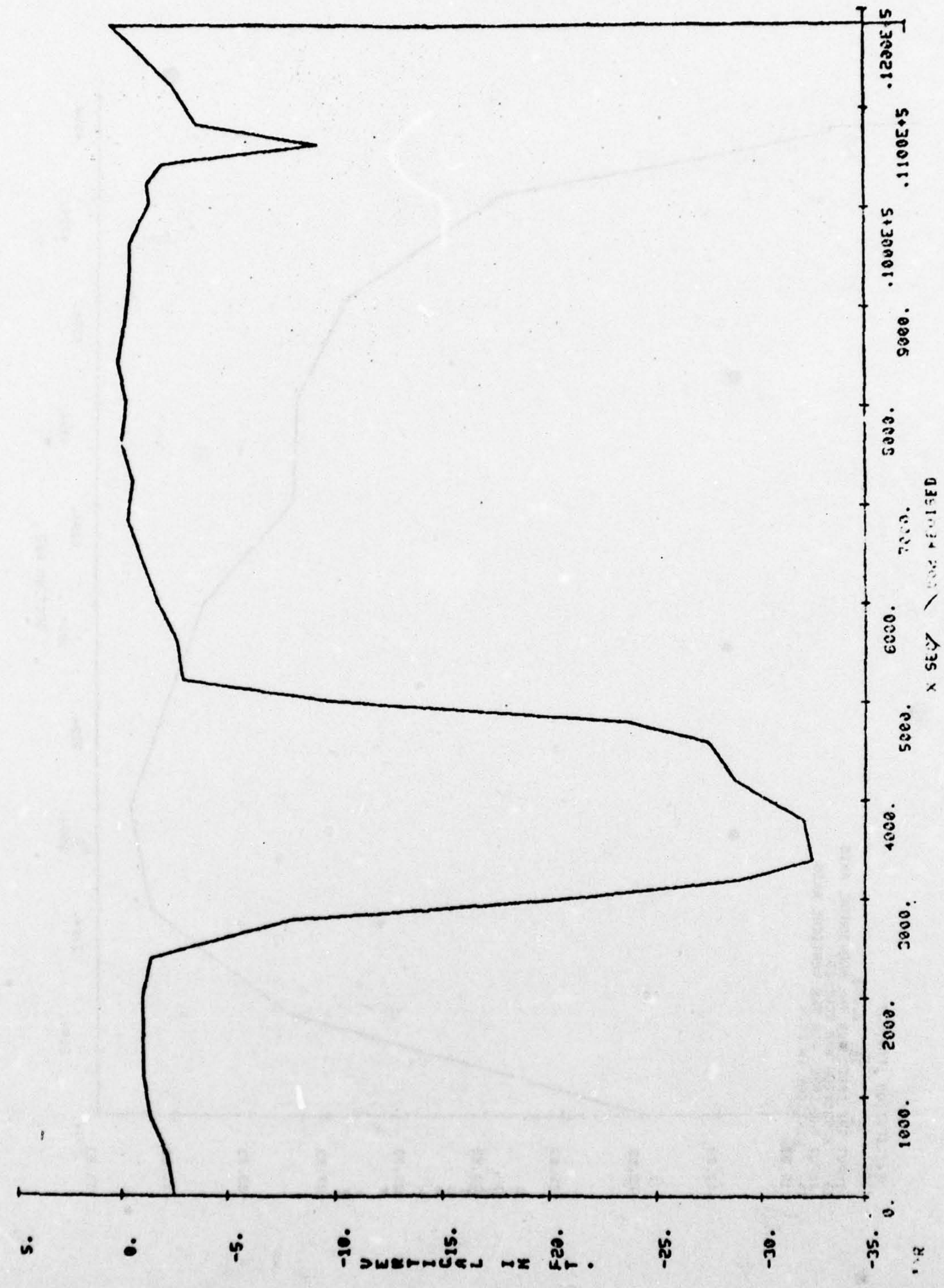

2.5
0.
-2.5
-5.
-7.5
-10.
-12.5
-15.
-17.5
-20.
-22.5
-25.
-27.5
VERTICAL
0.
1000.
2000.
3000.
4000.
5000.
6000.
7000.
8000.
9000.
.1000E+5
.1100E+5
.1200E+5
.1300E+5
.1400E+5
.1500E+5
.1600E+5
.1700E+5
IDNEXT

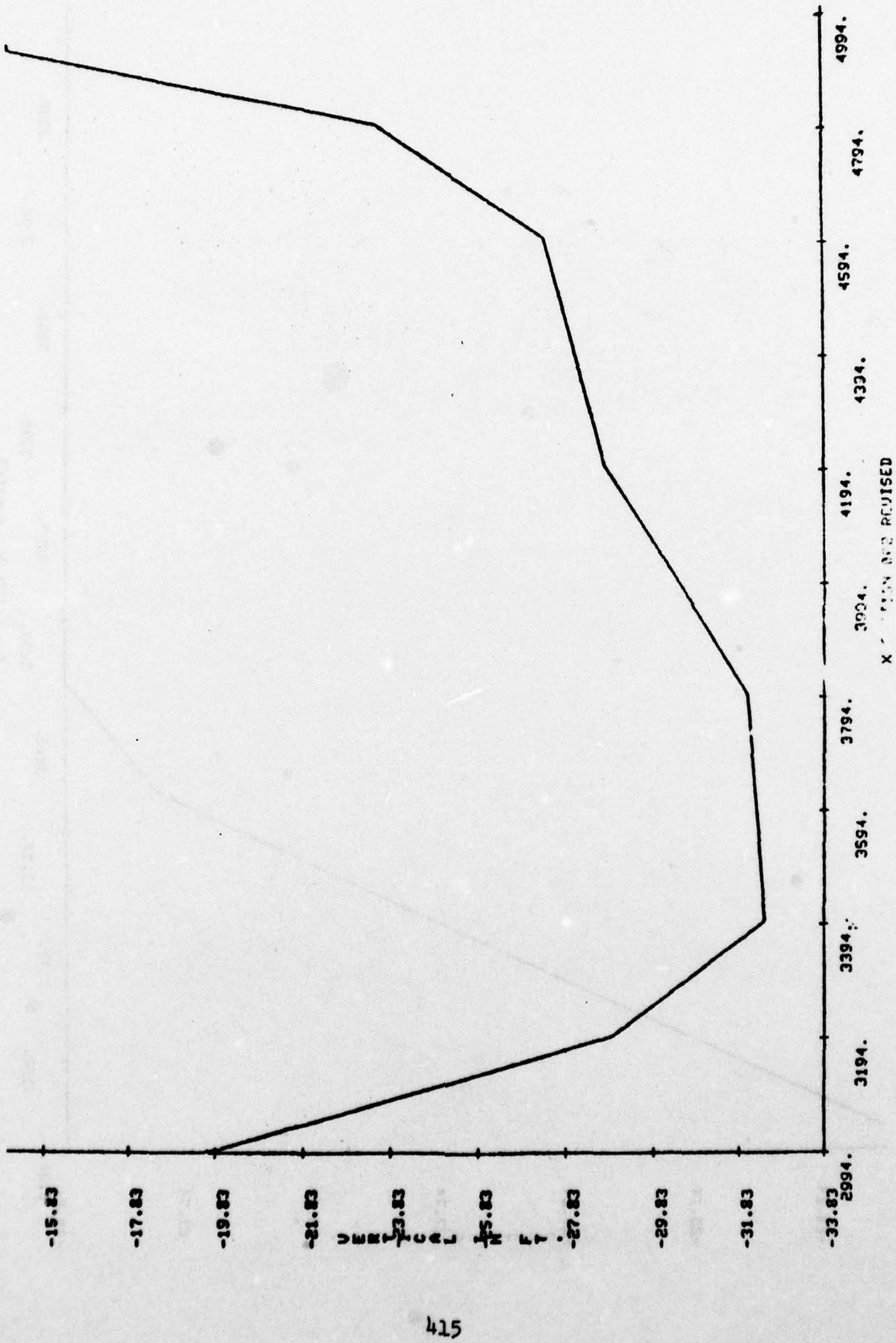


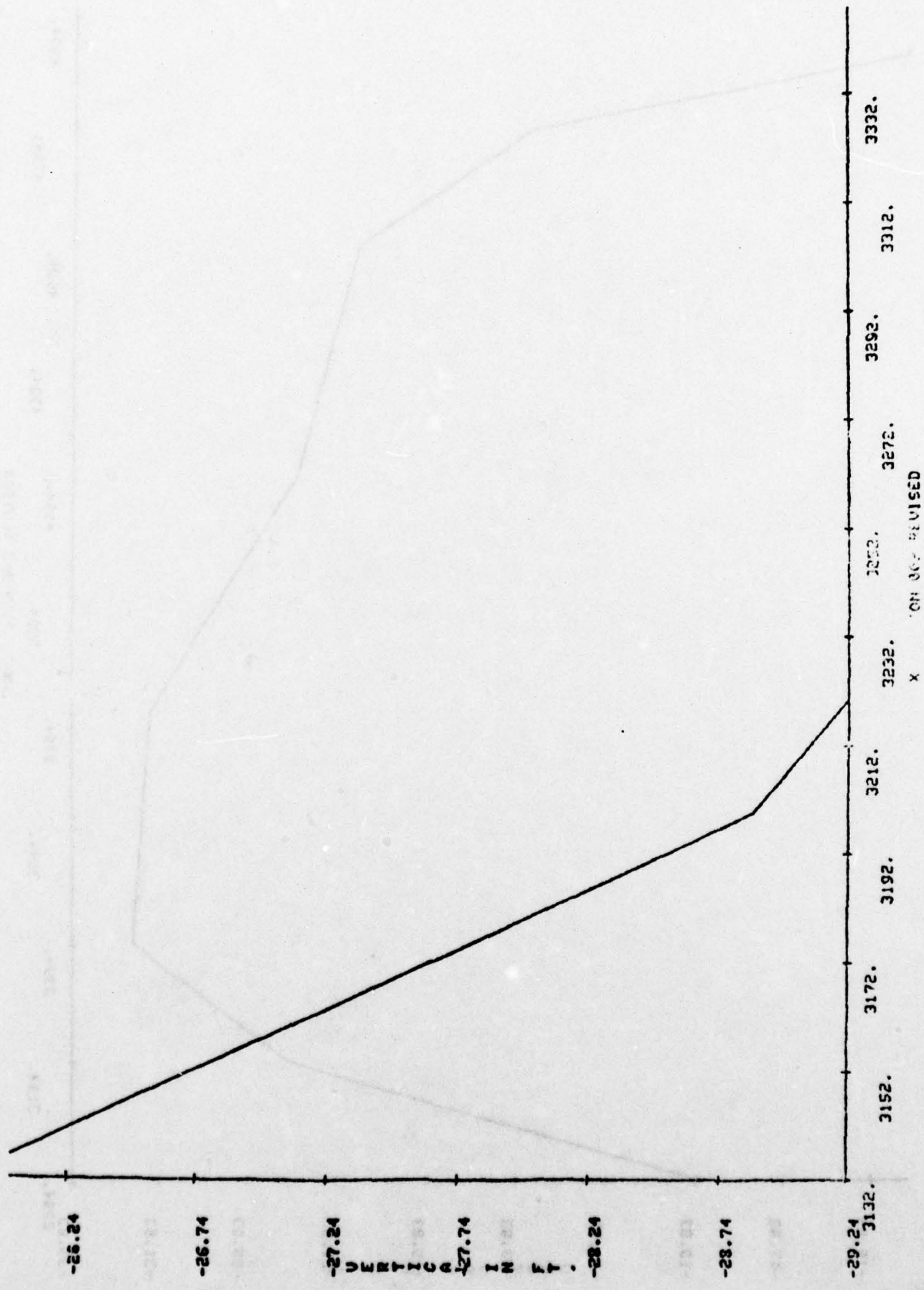
5.
0.
-5.
-10.
-15.
-20.
-25.
-30.
-35.
VERTICAL IN FT.
0.
1000.
2000.
3000.
4000.
5000.
6000.
7000.
8000.
9000.
.1000E+5
.1100E+5
.1200E+5
X SECTION 002

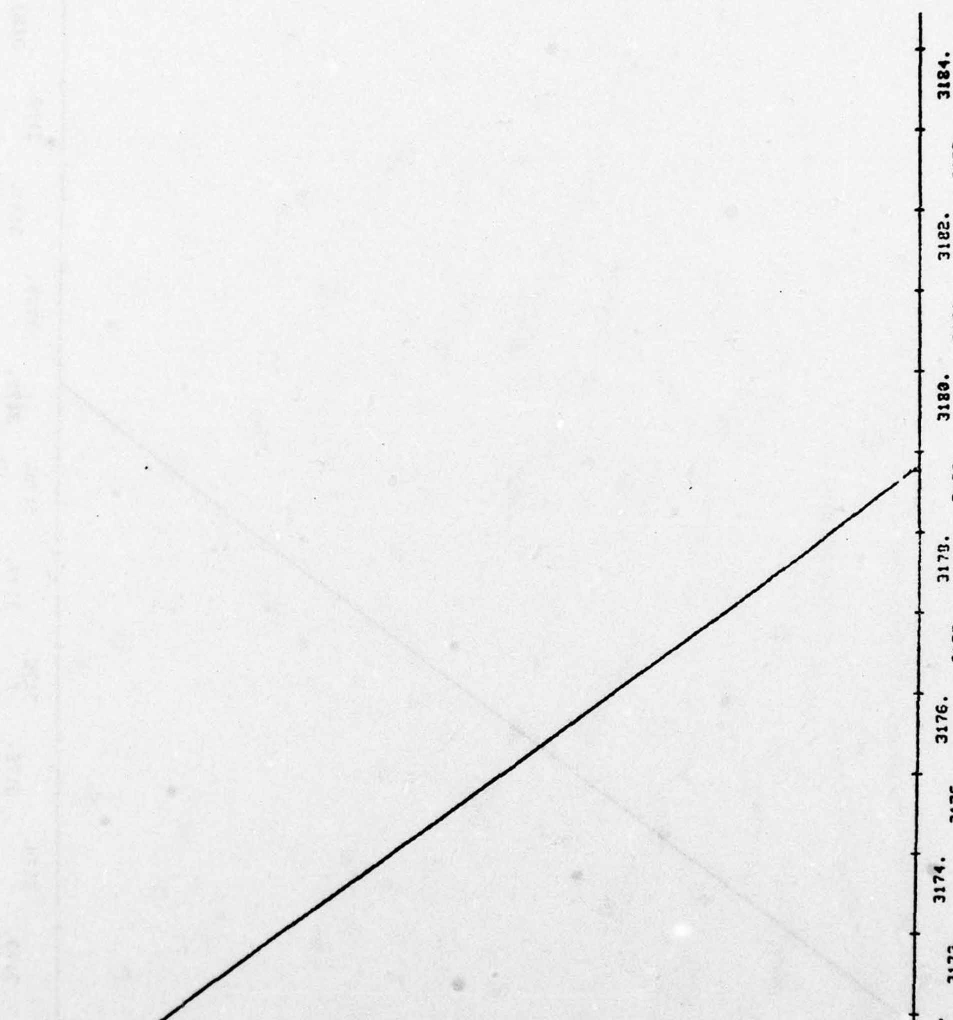
```
NEXT SECTION (FMT I3)
I>002
     2       36     0.000
INPUT THE LABEL FOR THE HORIZONTAL AXIS
I>    X SECTION 002 REVISED\
INPUT THE LABEL FOR THE VERTICAL AXIS
I>    VERTICAL IN FT.\
```



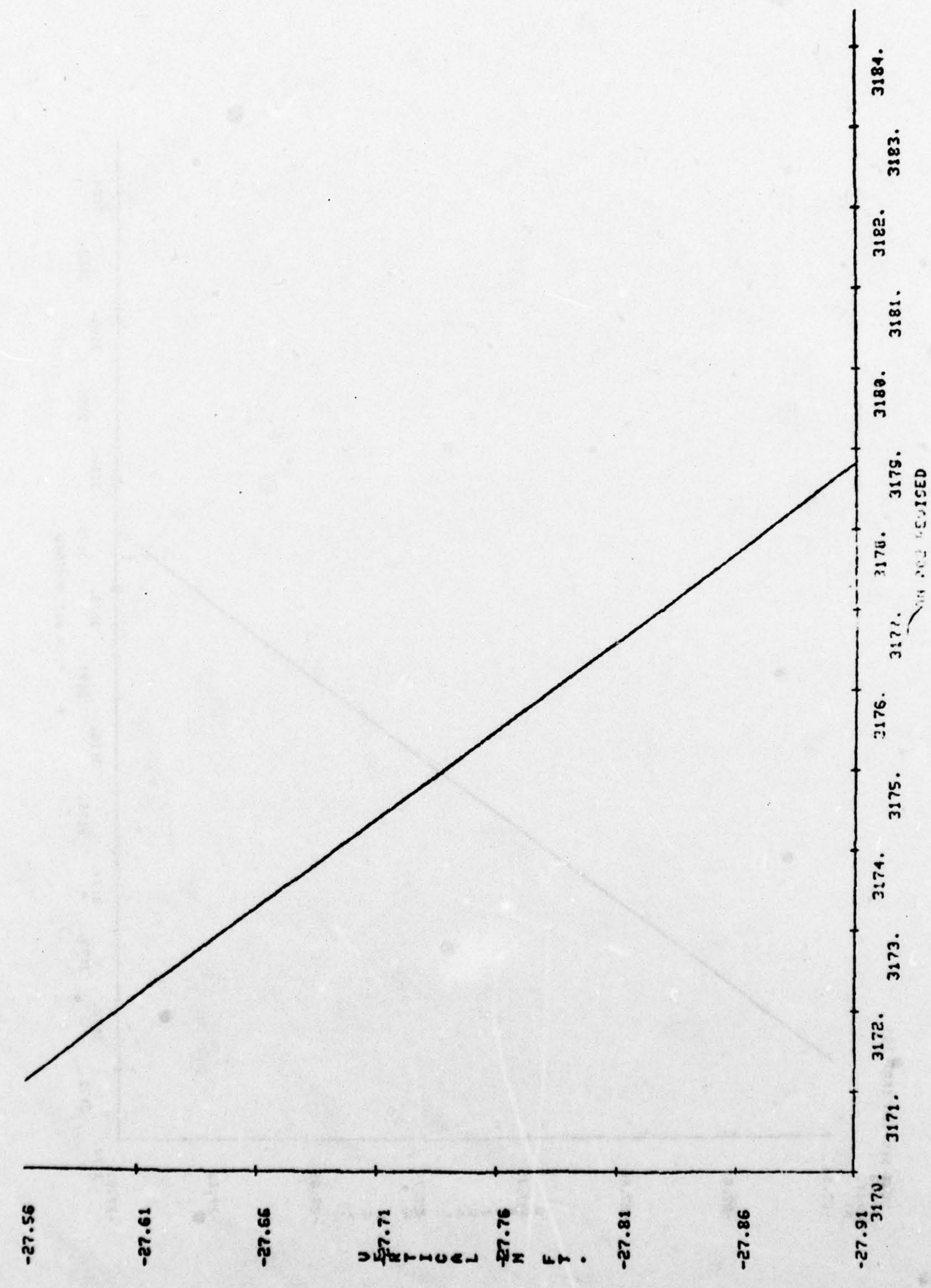

VERTICAL IN FT.
5.
0.
-5.
-10.
-15.
-20.
-25.
-30.
-35.
0.
1000.
2000.
3000.
4000.
5000.
6000.
8000.
9000.
.1000E+5
.1100E+5
.1200E+5


-15.83
-17.83
-19.83
-21.83
-23.83
-25.83
-27.83
-29.83
-31.83
-33.83
2994.
3194.
3394.
3594.
3794.
3994.
4194.
4394.
4594.
4794.
4994.


-26.24
-26.74
-27.24
-27.74
-28.24
-28.74
-29.24
VERTICAL IN FT.
3132.
3152.
3172.
3192.
3212.
3232.
3272.
3292.
3312.
3332.
REVISED



NEXT SECTION (FMT I3)
EXIT.
-27.56
-27.61
-27.66
-27.71
-27.76
-27.81
-27.86
-27.91
3170.
3171.
3172.
3173.
3174.
3175.
3176.
3177.
3178.
3179.
3180.
3181.
3182.
3183.
3184.
REVISED


-27.56
-27.61
-27.66
-27.71
-27.76
-27.81
-27.86
-27.91
VERTICAL IN FT.
3170.
3171.
3172.
3173.
3174.
3175.
3176.
3177.
3178.
3179.
3180.
3181.
3182.
3183.
3184.

POST PROCESSOR OF HEC-2 MODEL

Backwater analysis program authored by Hydraulic Engineering Center is used nationwide for planning informations. This program has a capability of plotting the longitudinal profile for different parameters on line printer; but to get an off line plot on CALCOMP or any other similar plotter, it necessitates a post processor.

This post processor authored by Huntington District uses the part of the output of HEC2 as input of the program. It has an additional feature of punching cards in the format of input required to run the program after making modifications without running HEC2. The use of the program with different parameters is described in the following pages.

CARD NO.	
1	Colums 2 thru 80 will be printed as a header on the printout.
2	TEMP(9) specifies whether or not symbols are to be used on the profile. When TEMP(9) is blank or equal to "0", a straight line plot without symbols will be drawn for each profile. When the integer portion (left side of the decimal) is equal to "1", a straight line plot with symbols at each point will be drawn for each profile. When the integer portion is equal to "-1", a plot with symbols and no connecting lines will be drawn for each profile. The decimal portion (right side of the decimal) specifies the symbol size in decimal inches. Symbols are automatically alternated for each different profile.
3	When INTYPE (Card 1) is "1", IFILE refers to the profile number to be plotted from the HEC 2 Data File (disc).

722 Al 41P - Cont'd

Card No.

3 Cont'd ICOL refers to the Column Number to be plotted from the HEC 2 Data File (Disc); refer to Tape 95.

The section number (Column 8) and the non-cum. reach length (Column 9) of Tape 95 are obtained automatically for each run.

When INTYPE(Card 1) is "2", a "1" for ICOL corresponds to the field to be plotted from a deck of cards.

The first field for Card 3 is always blank.

722 Al 41P - Cont'd

SPECIAL NOTES:

1. A maximum of eight profiles can be plotted from one set of cards, types 2 and 3.

2. Maximum number of sections to be plotted per profile is 590.

3. Format used when punching data cards:

   Section No. Field 1 F8.2

   Profile Elevations for Profile 1 to 8 Fields 2 thru 9 F8.2

   Reach Length Columns 73 thru 80 F8.2

4. Program automatically alternates four pen positions.

5. HEC2 and 722 Al 41P must be run simultaneously IF INTYPE=1

6. Y-axis is feet to inch
   X-axis is mile to inch if plotting in miles
   " " feet " " " " " feet

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM		PROGRAM NO.
Backwater Analysis Plot		722 A1 41P

PREPARING AGENCY

U. S. Army Engineer District, Huntington

AUTHOR	DATE PROGRAM COMPLETED	STATUS OF PROGRAM Phase	Stage
E. A. Stone (722 2141P) Modified by Harold McClung	4 April 1977		

A. PURPOSE OF PROGRAM

To generate backwater profile plots using data supplied by HEC2 program or card data from previous run of 722 A1 41P.

B. PROGRAM SPECIFICATIONS

The program consists of four subprograms and requires basic CALCOMP plot software. There are approximately 450 Fortran IV statements.

C. METHODS

Program reads header card, parameter cards and disc or card profile data. On basis of parameters selects profiles to be plotted, generates punched profile data and create plot instructions for plotting selected profiles.

D. EQUIPMENT DETAILS

CDC 7600 Computer BKY operating system (LBL modification of CDC Scope 1 System) supplied by Lawrence Berkeley Laboratory. Cope 1200 remote batch terminal with card reader, line printer, card punch and tape drive.

E. INPUT-OUTPUT

Program reads punched cards containing parameter data and optional card profile data if not supplied by HEC2 disc file. Output is printed table for each profile containing section numbers, elevation, milepoint and reach length; plot tape for all selected profiles; and optional punched cards for all selected profiles.

F. ADDITIONAL REMARKS

This is a modification of 722 81 41P. Adjustments were made so program would run on BKY system and would read new HEC2 disc file format. The most extensive changes were made in subroutines FILBLD and FILCNT.

MULTIPLE-CARD LAYOUT

For use of this form, see AR 18-7; the proponent agency is Office of the Assistant Vice Chief of Staff.

SYSTEM		PREPARED BY	PAGE NO. / NO. OF PAGES
722 A1 41P (LBL)	April 4, 1977	Harold McClung ADP Center	1 / 1

CARD 1

INTYPE (col 1)	Columns 2–79
I1	1 - HEC data is input from a disc file 2 - " " " " " cards IHEADER Columns 2 thru 79 are for free form header which describes profiles, project or gives other descriptive information. 13A6,A1

CARD 2

TEMP(1)	TEMP(2)	TEMP(3)	TEMP(4)	TEMP(5)	TEMP(6)	TEMP(7)	TEMP(8)	TEMP(9)	TEMP(10)
Profile Number	Y-Axis Scale	Beginning Y-Axis Value	Last Y-Axis Value	X-Axis Scale	Actual Beginning X-Axis Value	Last X-Axis Value	*See Note	Symbol Option & Symbol Size	*See Note
F8.0	F8.0	F8.0	F8.0	F8.0	F8.0	F8.0	F8.0	F8.0	F8.0

CARD 3

Columns 1–13	IFIL(1)	ICOL(1)	IFIL(2)	ICOL(2)	IFIL(3)	ICOL(3)	IFIL(4)	ICOL(4)	IFIL(5)	ICOL(5)	IFIL(6)	ICOL(6)	IFIL(7)	ICOL(7)	IFIL(8)	ICOL(8)
Profile Number & Field Number to be selected for plotting this run	I2	I1	I2	I1	I2	I1	I2	I1	I2	I1	I2	I1	I2	I1	I2	I1

CARD 4

-999999.	If CARD 1 is " 2 " card input is inserted just prior to this card. This card indicates end of data.

NOTE

Cards 2 and 3 are repeated for each additional series of plots.

CARD 2: TEMP(8) integer portion - 1-if cummulative reach length 0-if non-cummulative reach length
" first position to right of decimal point - 0 = plot miles 1 = plot feet
" second " " " " " " - No. decimal places to be printed on Y-Axis
" third " " " " " " - " " " " " " " X-Axis

TEMP(9) integer portion 1-symbol plotted with connecting line 0-line plot no symbols
-1-symbol plotted no connecting line
" decimal " symbol height in decimal inches

TEMP(10) integer portion -1 = plot next set of data on same axis 1 = advance paper for new plot
" decimal " 0 = no punched output 1 = punched output (only if INTYPE = 1)

Plotting from disc file using HEC A1 41P package

```
T1         PAINTSVILLE  KENTUCKY
T2         LEVISA FORK  RIVER MILE 38.14 TO 39.35
T3         LEVISA  FORK    FEB.  1977
J1  -10.     3.0                                                         ←HEC2 data
J2   1.0            -1.0
J3  38.      1.      4.       13.     14.      15.   26.   55.   56.   200.
J5 -10.

  ETC.
ER
7/8/9 multipunch in column 1
```

The following is input for 722 A1 41P

```
1 WOLF CREEK VA   FROM RUN  1
                                                                    No Symbol on Plot
                                                                    (Need not be key-
                                                                     punched)
    -1.     20.  1520.0  1780.0     0.5   0.062     12.0     .002        0          1.1
            15       16
-999999.
```

Column to be plotted from Data File WCVNVA.DM (or Your File)

Profile Number to be plotted from your Data File.

NOTE: Exact beginning mile of first section to be plotted

Punched output option

722 Al 41P

PLOTTING FROM DECK OF CARDS using ONLY 722 Al 41P package

NOTE: (-1) Profile 1 & 2 will both plot on same axis

Alter. Symbols with Connecting Line

Symbol Size (0.1 inch)

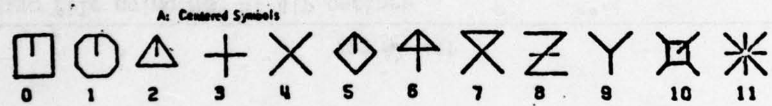
```
CARD NO.
 1        2 SAMPLE RUN    NOVEMBER 11, 1976
 2          -1.      10.     720.     770.     .2      5.      10.4   1.001      1.1      -1.
 3                          1        1         1
              24.50   728.50   741.16   743.12   0.      0.      0.      0.        0.      0.0
        DATA  25.00   729.20   742.59   744.76   0.      0.      0.      0.        0.   2030.
              26.00   729.80   743.39   745.52   0.      0.      0.      0.        0.   3244.
              27.00   730.10   744.09   746.22   0.      0.      0.      0.        0.   4458.
          ETC.
 2          -1.      10.     720.     770.     .2      5.      10.4    .001     -1.1      -1.
 3                                   1         1
              24.50   728.50   743.93   747.42   0.      0.      0.      0.        0.      0.0
        DATA  25.00   729.20   745.72   750.29   0.      0.      0.      0.        0.   2030.
              26.00   729.80   746.43   751.05   0.      0.      0.      0.        0.   1214.
              27.00   730.10   747.10   751.74   0.      0.      0.      0.        0.   1214.
          ETC.
 4        -999999.
```

Column 72

Alternating Symbols on each section with no connecting line.

Possible Symbols:

A: Centered Symbols

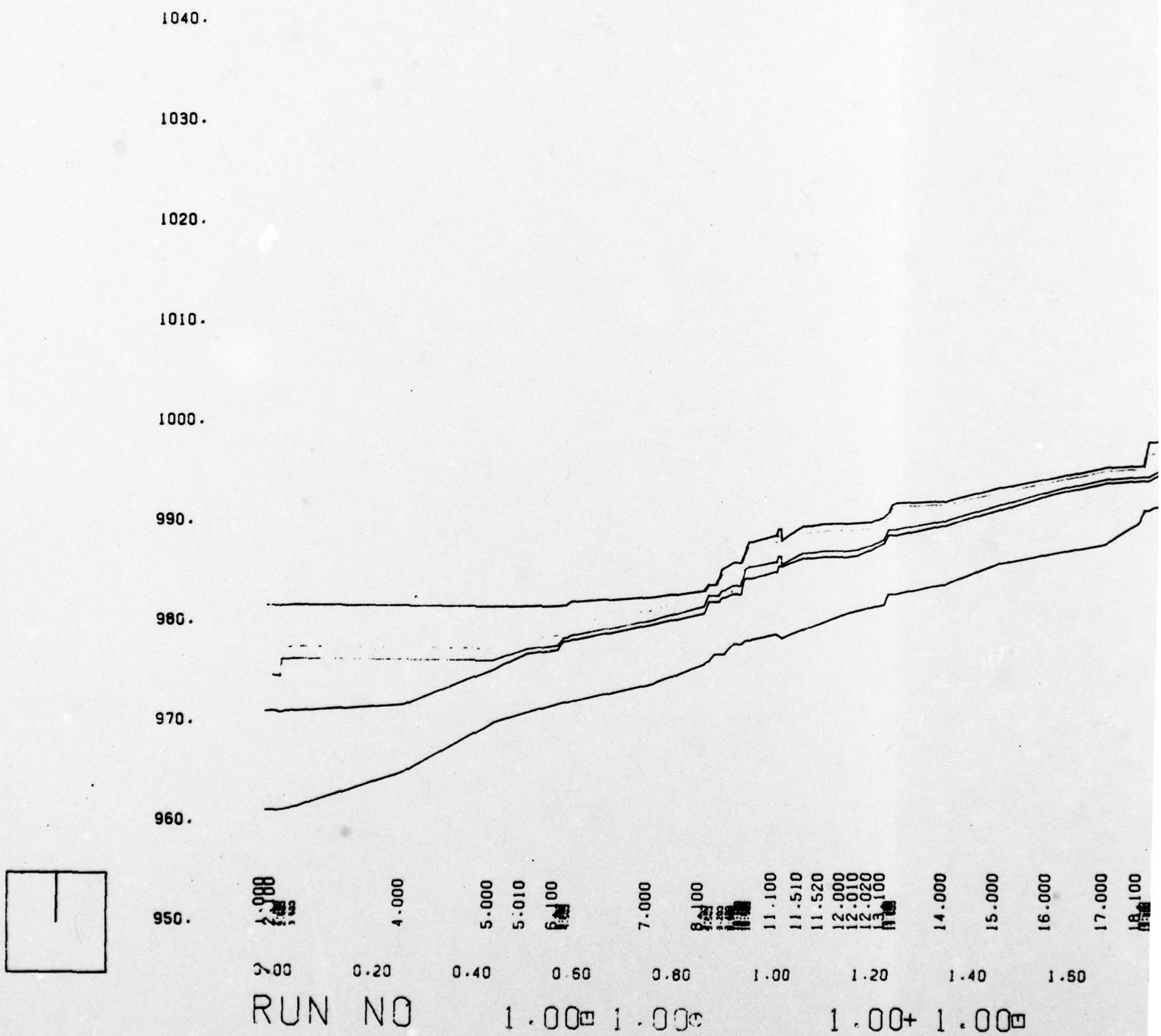


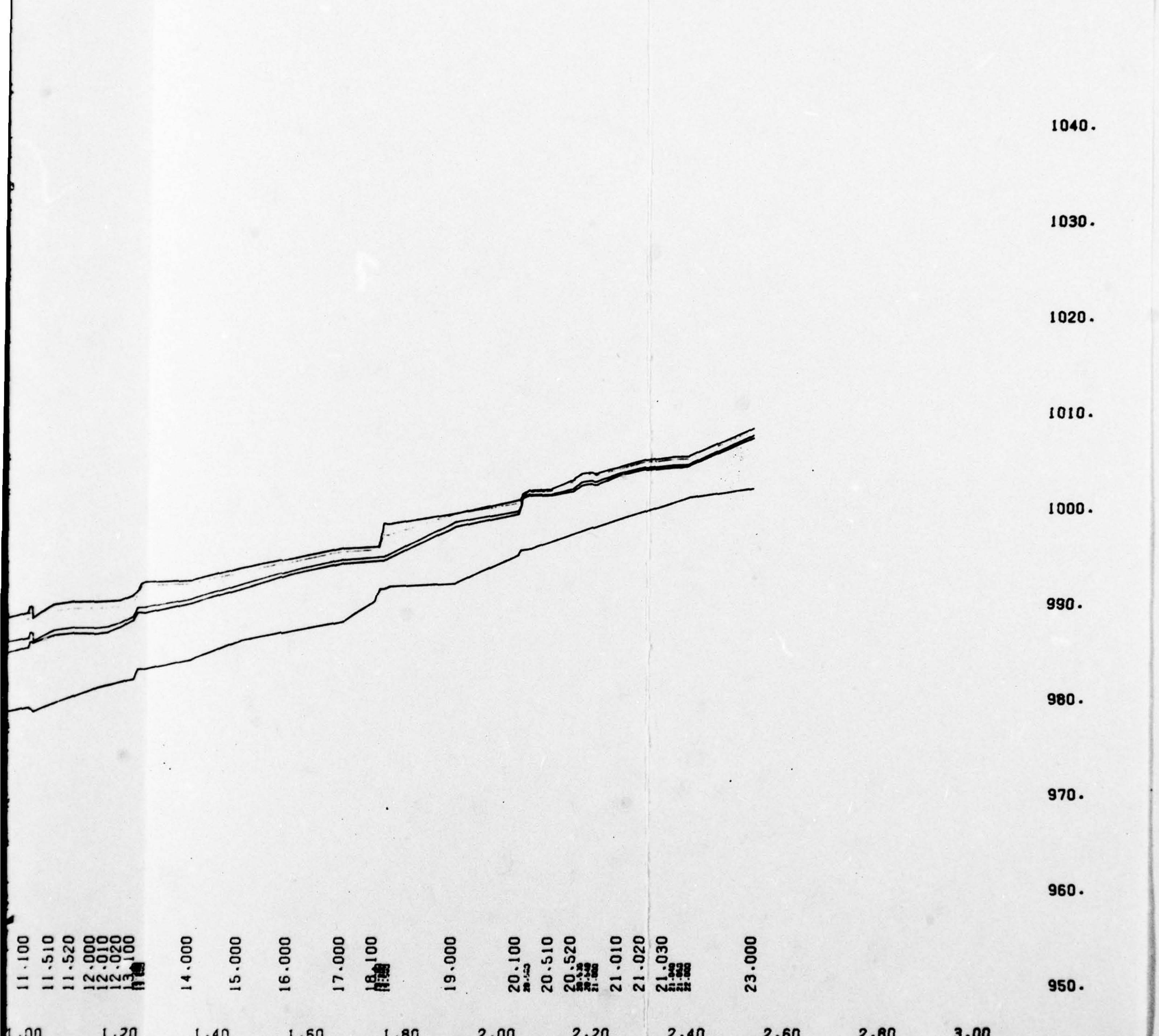
722 A1 41P

Copy of Tape 95 on File (Disc)
Partial Listing of Data as used in 722 A1 41P

1 DELMX.	2 RBEL	3 XLBEL	4 CRIWS	5 ELMIN	6 WSEL	7 EG	8 SECNO	9 XLCH
1590.00	1524.00	1524.00	0.	1522.00	1568.50	1568.52	1.00	0.
1590.00	1524.00	1524.00	0.	1522.00	1568.50	1568.52	2.10	167.30
1590.00	1558.60	1558.00	0.	1522.70	1568.48	1568.53	2.20	225.38
1590.00	1558.50	1550.00	0.	1522.70	1568.69	1568.77	2.40	260.38
1590.00	1525.00	1525.00	0.	1523.00	1568.69	1568.77	2.50	313.18
1590.00	1525.00	1525.00	0.	1523.00	1568.87	1568.79	3.10	561.42
1590.00	1539.70	1539.70	0.	1522.20	1568.68	1568.79	3.20	605.94
1590.00	1529.20	1539.70	0.	1522.20	1569.13	1569.32	3.40	637.14
1590.00	1525.00	1525.00	0.	1523.00	1569.06	1569.38	3.50	659.94
1700.00	1525.00	1525.00	0.	1523.00	1568.97	1569.44	3.60	834.24
1550.00	1527.00	1527.00	0.	1525.00	1568.68	1569.69	4.00	1332.24
1580.00	1533.00	1533.00	0.	1529.00	1569.30	1569.99	5.10	1753.44
1550.00	1533.00	1533.00	0.	1529.00	1569.81	1570.00	5.20	1833.44
1650.00	1539.00	1539.00	0.	1535.00	1570.12	1570.32	5.40	1841.44
1650.00	1539.00	1539.00	0.	1535.00	1570.12	1570.32	5.50	1891.44
1670.00	1539.00	1539.00	0.	1534.50	1570.22	1570.33	6.00	2090.98
1600.00	1539.00	1539.00	0.	1536.00	1570.27	1570.36	7.10	2727.45
1600.00	1555.30	1553.00	0.	1535.40	1570.28	1570.37	7.20	2790.81
1600.00	1555.30	1544.00	0.	1535.40	1570.65	1570.72	7.40	2827.31

** NOTE : Fields 1 thru 9 above are fields 63, 24, 23, 2, 42, 1, 3, 38, and 39 respectively on Tape 95 as output from the HEC2 program.


1040.
1030.
1020.
1010.
1000.
990.
980.
970.
960.
950.
4.000
5.000
5.010
7.000
11.100
11.510
11.520
12.000
12.010
12.020
13.100
14.000
15.000
16.000
17.000
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
RUN NO
1.00 1.00 1.00+ 1.00


1040.
1030.
1020.
1010.
1000.
990.
980.
970.
960.
950.
11.100
11.510
11.520
12.000
12.010
12.020
13.100
14.000
15.000
16.000
17.000
18.100
19.000
20.100
20.510
20.520
21.010
21.020
21.030
23.000
.00
1.20
1.40
1.60
1.80
2.00
2.20
2.40
2.60
2.80
3.00
1.00+ 1.00

CRITIQUE

COMPUTER GRAPHICS COLLOQUIUM

1-3 Aug 78

CRITIQUE

Name: ______________________(Optional)

Office: ____________________

Supervisor ____ Non-Supervisor ____ ADPC ___ Non-ADPC ___

* *

Your response to these questions will enable us to better plan for future needs in computer graphics.

A. Colloquium

1. Did it meet with your expectations? Yes____, No___, Partially ___
2. How was the colloquium oriented? ADP ____, Users ____, Balanced ____, None of the preceding _____
3. Was the interactive & passive parallel sessions useful? Yes ____, No ____, Moderate ____
4. In future colloquiums do you want?

   More workshops __________
   Less workshops __________
   More lectures __________
   Less lectures __________
   As is __________

5. Did you learn of any graphics application in the colloquium that you would use immediately? Yes _____, No _____
6. Do you think we need to have such colloquiums

   Once a year ______________
   Once every other year ________
   Never ___________

7. Other Remarks on the Colloquium?

B. Dissemination

1. Did the Colloquium disseminate information useful to you/your office? Yes ________, No ________

2. Is this an effective means of dissemination? Yes ________, No ________

3. If you need a new graphics application, will you talk to one of the Graphics Users Committee (GUC) members? Yes ________, No ________

4. Do you need more training in

   a. Using graphics programs? Yes ________, No ________

   b. Writing graphics programs? Yes ________, No ________

5. Do you have an article on computer applications that you would like to contribute to the Engineering Computer Notes (ECN)? Yes ___, No ___
   If Yes, give name & office.

   Name ____

   Office ____

6. What else can be done to improve dissemination of graphics and other computer programs?

____

____

____

____

____

____

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____

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____

____

____

C. Standards

1. Do you think that a standard graphics system help in exchanging programs in the future? Yes __________, No _________

2. Should the Corps adopt a standard/preferred graphics system? Yes __________, No _________

3. What are the ingredients you think a standard/preferred graphics system have?

	Yes	No
a. FORTRAN subroutines	___	__
b. Modular concept	___	__
c. Good documentation	___	__
d. Device independence	___	__
e. Host computer independence	___	__
f. Must run in major & minicomputers	___	__
g. Good maintenance	___	__
h. Calcomp calls	___	__
i. Non proprietary	___	__
j. Others	___	__

4. Do you know a preferred graphics system that could serve as a standard Corps system? Yes _____, No _____

   If Yes, Name the System: ____

5. Should Applications programs be standardized? Yes _____ No ____

D. General

1. Do you use any Interactive graphics plotters in your office? Yes____, No ____
   If No, do you think you need to have one? Yes ____, No ____

2. Do you think that graphics could be a cost-effective tool for engineers?
   Yes _____, No_____

3. Do you think an engineering software center for engineering programs (similar to the Engineering Data Processing Center (EDPC) for business programs) needed in the Corps? Yes _____, No _____

ATTENDEES CRITIQUES

COMPUTER GRAPHICS COLLOQUIUM

1-3 Aug 78

ADP	=	26(43%)
NON-ADP	=	35(57%)
SUPERVISOR	=	15(25%)
NON-SUPERVISOR	=	46(75%)

COLLOQUIUM (ADPC)

1. Did it meet with your expectations? YES 77%, NO 4%, PARTIALLY 19%

2. How was the colloquium oriented? ADP 4%, USERS 4%, BALANCED 92%,
   NONE OF THE PRECEDING 0%

3. Was the interactive & passive parallel sessions useful? YES 81%, NO 4%, MODERATE 8%

4. In future colloquiums do you want?

   More workshops 42%
   Less workshops 0%
   More lectures 15%
   Less lectures 46%
   As is 0%

5. Did you learn of any graphics application in the colloquium that you would use immediately? YES 73%, NO 27%

6. Do you think we need to have such colloquiums

   Once a year 46%
   Once every other year 54%
   Never 0%

DISSEMINATION

1. Did the Colloquium disseminate information useful to you/your office? YES 96% , NO 0%

2. Is this an effective means of dissemination? YES 96% , NO 4%

3. If you need a new graphics application, will you talk to one of the Graphics Users Committee (GUC) members? YES 85% , NO 8%

4. Do you need more training in

   a. Using graphics programs? YES 62% , NO 27%

   b. Writing graphics programs? YES 73% , NO 15%

5. Do you have an article on computer applications that you would like to contribute to the Engineering Computer Notes (ECN)? YES 4% , NO 77%

STANDARDS

1. Do you think that a standard graphics system help in exchanging programs in the future? YES 65%, NO 19%

2. Should the Corps adopt a standard/ preferred graphics system? YES 73%, NO 12%

3. What are the ingredients you think a standard/preferred graphics system have?

		YES	NO
a.	FORTRAN subroutines	85%	0%
b.	Modular concept	81%	0%
c.	Good documentation	88%	0%
d.	Device independence	73%	12%
e.	Host computer independence	77%	12%
f.	Must run in major & minicomputers	73%	0%
g.	Good maintenance	85%	0%
h.	Calcomp calls	62%	4%
i.	Non-prioprietary	77%	4%
j.	Others	12%	4%

4. Do you know a preferred graphics system that could serve as a standard Corps system?

YES 38%, NO 42%

If Yes, Name the System: GCS = 91% Calcomp = 9%

5. Should Applications programs be standardized? YES 15%, NO 58%

GENERAL

1. Do you use any Interactive graphics plotters in your office?

   YES 77% NO 19%

   If No, do you think you need to have one? YES 19%, NO 0%

2. Do you think that graphics could be a cost-effective tool for engineers?

   YES 92%, NO 0%

3. Do you think an engineering software center for engineering programs (similar to the Engineering Data Processing Center (EDPC) for business programs) needed in the Corps?

   YES 46%, NO 26%

COLLOQUIUM (Non-ADPC)

1. Did it meet with your expectations? YES 69%, NO 0%, PARTIALLY 31%

2. How was the colloquium oriented? ADP 31%, USERS 3%, BALANCED 66%, NONE OF THE PRECEDING 0%

3. Was the interactive & passive parallel sessions useful? YES 71%, NO 6%, MODERATE 23%

4. In future colloquiums do you want?

More workshops	60%
Less workshops	3%
More lectures	14%
Less lectures	17%
As is	26%

5. Did you learn of any graphics application in the colloquium that you would use immediately? YES 60%, NO 34%

6. Do you think we need to have such colloquiums

Once a year	66%
Once every other year	34%
Never	0%

DISSEMINATION

1. Did the Colloquium disseminate information useful to you/your office? YES 94%, NO 3%

2. Is this an effective means of dissemination? YES 86%, NO 6%

3. If you need a new graphics application, will you talk to one of the Graphics Users Committee (GUC) members? YES 71%, NO 20%

4. Do you need more training in

   a. Using graphics programs? YES 63%, NO 20%

   b. Writing graphics programs? YES 69%, NO 20%

5. Do you have an article on computer applications that you would like to contribute to the Engineering Computer Notes (ECN)? YES 9%, NO 77%

<u>STANDARDS</u>

1. Do you think that a standard graphics system help in exchanging programs in the future? YES 94%, NO 6%

2. Should the Corps adopt a standard/preferred graphics system? YES 86%, NO 14%

3. What are the ingredients you think a standard/preferred graphics system have?

	YES	NO
a. FORTRAN subroutines	97%	3%
b. Modular concept	89%	3%
c. Good documentation	100%	0%
d. Device independence	83%	9%
e. Host computer independence	83%	6%
f. Must run in major & minicomputers	80%	14%
g. Good maintenance	97%	0%
h. Calcomp calls	43%	26%
i. Non-priopríetary	86%	6%
j. Others	9%	3%

4. Do you know a preferred graphics system that could serve as a standard Corps system?

YES 37%, NO 43%

If Yes, Name the System: GCS = 91% Calcomp = 9%

5. Should <u>Applications</u> programs be standardized? YES 34%, NO 43%

GENERAL

1. Do you use any Interactive graphics plotters in your office?

YES 54% NO 46%

If No, do you think you need to have one? YES 94% , NO 0%

2. Do you think that graphics could be a cost-effective tool for engineers?

YES 100% , NO 0%

3. Do you think an engineering software center for engineering programs (similar to the Engineering Data Processing Center (EDPC) for business programs) needed in the Corps?

YES 63% , NO 34%

COLLOQUIUM (Supervisor)

1. Did it meet with your expectations? YES 80%, NO 0%, PARTIALLY 20%

2. How was the colloquium oriented? ADP 13%, USERS 7%, BALANCED 80%, NONE OF THE PRECEDING 0%

3. Was the interactive & passive parallel sessions useful? YES 80%, NO 0%, MODERATE 13%

4. In future colloquiums do you want?

More workshops	33%
Less workshops	0%
More lectures	13%
Less lectures	0%
As is	4%

5. Did you learn of any graphics application in the colloquium that you would use immediately? YES 80%, NO 20%

6. Do you think we need to have such colloquiums

Once a year	40%
Once every other year	60%
Never	0%

DISSEMINATION

1. Did the Colloquium disseminate information useful to you/your office? YES 100%, NO 0%

2. Is this an effective means of dissemination? YES 100%, NO 0%

3. If you need a new graphics application, will you talk to one of the Graphics Users Committee (GUC) members? YES 93%, NO 7%

4. Do you need more training in
   a. Using graphics programs? YES 47%, NO 33%
   b. Writing graphics programs? YES 73%, NO 7%

5. Do you have an article on computer applications that you would like to contribute to the Engineering Computer Notes (ECN)? YES 0%, NO 67%

STANDARDS

1. Do you think that a standard graphics system help in exchanging programs in the future? YES 80%, NO 13%

2. Should the Corps adopt a standard/preferred graphics system? YES 80%, NO 13%

3. What are the ingredients you think a standard/preferred graphics system have?

	YES	NO
a. FORTRAN subroutines	87%	0%
b. Modular concept	80%	7%
c. Good documentation	87%	0%
d. Device independence	73%	13%
e. Host computer independence	87%	0%
f. Must run in major & minicomputers	80%	7%
g. Good maintenance	80%	0%
h. Calcomp calls	47%	20%
i. Non-prioprietary	73%	13%
j. Others	20%	13%

4. Do you know a preferred graphics system that could serve as a standard Corps system?

YES 40%, NO 53%

If Yes, Name the System: GCS = 100% Calcomp = 0%

5. Should Applications programs be standardized? YES 13%, NO 53%

GENERAL

1. Do you use any Interactive graphics plotters in your office?

   YES 67% NO 27%

   If No, do you think you need to have one? YES 100% , NO 0%

2. Do you think that graphics could be a cost-effective tool for engineers?

   YES 93% , NO 0%

3. Do you think an engineering software center for engineering programs (similar to the Engineering Data Processing Center (EDPC) for business programs) needed in the Corps?

   YES 53% , NO 33%

COLLOQUIUM (Non-Supervisor)

1. Did it meet with your expectations? YES 70%, NO 2%, PARTIALLY 28%

2. How was the colloquium oriented? ADP 22%, USERS 2%, BALANCED 76%, NONE OF THE PRECEDING 0%

3. Was the interactive & passive parallel sessions useful? YES 74%, NO 7%, MODERATE 17%

4. In future colloquiums do you want?

More workshops	59%
Less workshops	2%
More lectures	15%
Less lectures	15%
As is	30%

5. Did you learn of any graphics application in the colloquium that you would use immediately? YES 61%, NO 35%

6. Do you think we need to have such colloquiums

Once a year	63%
Once every other year	37%
Never	0%

DISSEMINATION

1. Did the Colloquium disseminate information useful to you/your office? YES 93%, NO 2%

2. Is this an effective means of dissemination? YES 87%, NO 7%

3. If you need a new graphics application, will you talk to one of the Graphics Users Committee (GUC) members? YES 72%, NO 17%

4. Do you need more training in

   a. Using graphics programs? YES 67%, NO 20%

   b. Writing graphics programs? YES 70%, NO 22%

5. Do you have an article on computer applications that you would like to contribute to the Engineering Computer Notes (ECN)? YES 4%, NO 80%

STANDARDS

1. Do you think that a standard graphics system help in exchanging programs in the future? YES 83%, NO 11%

2. Should the Corps adopt a standard/ preferred graphics system? YES 80%, NO 13%

3. What are the ingredients you think a standard/preferred graphics system have?

	YES	NO
a. FORTRAN subroutines	93%	2%
b. Modular concept	87%	0%
c. Good documentation	98%	0%
d. Device independence	80%	9%
e. Host computer independence	78%	11%
f. Must run in major & minicomputers	76%	9%
g. Good maintenance	96%	0%
h. Calcomp calls	52%	15%
i. Non-priopprietary	85%	2%
j. Others	7%	0%

4. Do you know a preferred graphics system that could serve as a standard Corps system?

YES 37%, NO 39%

If Yes, Name the System: GCS = 88% Calcomp = 12%

5. Should Applications programs be standardized? YES 30%, NO 47%

GENERAL

1. Do you use any Interactive graphics plotters in your office?

   YES 63% NO 37%

   If No, do you think you need to have one? YES 94%, NO 0%

2. Do you think that graphics could be a cost-effective tool for engineers?

   YES 98%, NO 0%

3. Do you think an engineering software center for engineering programs (similar to the Engineering Data Processing Center (EDPC) for business programs) needed in the Corps?

   YES 57%, NO 30%

COLLOQUIUM (Total)

1. Did it meet with your expectations? YES 72%, NO 2%, PARTIALLY 26%

2. How was the colloquium oriented? ADP 20%, USERS 3%, BALANCED 77%, NONE OF THE PRECEDING 0%

3. Was the interactive & passive parallel sessions useful? YES 75%, NO 5%, MODERATE 16%

4. In future colloquiums do you want?

More workshops	52%
Less workshops	2%
More lectures	14%
Less lectures	11%
As is	34%

5. Did you learn of any graphics application in the colloquium that you would use immediately? YES 66%, NO 31%

6. Do you think we need to have such colloquiums

Once a year	57%
Once every other year	43%
Never	0%

DISSEMINATION

1. Did the Colloquium disseminate information useful to you/your office? YES 95%, NO 2%

2. Is this an effective means of dissemination? YES 90%, NO 5%

3. If you need a new graphics application, will you talk to one of the Graphics Users Committee (GUC) members? YES 77%, NO 15%

4. Do you need more training in

   a. Using graphics programs? YES 62%, NO 23%

   b. Writing graphics programs? YES 70%, NO 18%

5. Do you have an article on computer applications that you would like to contribute to the Engineering Computer Notes (ECN)? YES 7%, NO 77%

STANDARDS

1. Do you think that a standard graphics system help in exchanging programs in the future? YES 82%, NO 11%

2. Should the Corps adopt a standard/ preferred graphics system? YES 80%, NO 13%

3. What are the ingredients you think a standard/preferred graphics system have?

	YES	NO
a. FORTRAN subroutines	92%	2%
b. Modular concept	85%	2%
c. Good documentation	95%	0%
d. Device independence	79%	10%
e. Host computer independence	80%	8%
f. Must run in major & minicomputers	77%	8%
g. Good maintenance	92%	0%
h. Calcomp calls	51%	16%
i. Non-priopriety	82%	5%
j. Others	10%	3%

4. Do you know a preferred graphics system that could serve as a standard Corps system?

   YES 38%, NO 43%

   If Yes, Name the System: GCS = 91% Calcomp = 9%

5. Should Applications programs be standardized? YES 26%, NO 49%

GENERAL

1. Do you use any Interactive graphics plotters in your office?

YES 64% NO 34%

If No, do you think you need to have one? YES 95%, NO 0%

2. Do you think that graphics could be a cost-effective tool for engineers?

YES 97%, NO 0%

3. Do you think an engineering software center for engineering programs (similar to the Engineering Data Processing Center (EDPC) for business programs) needed in the Corps?

YES 56%, NO 31%

REMARKS

Attendees should be allowed more leeway in attending particular demonstrations. Some demonstrations were not alloted sufficient time for questions, discussion, etc. Demonstrations should be scheduled so that attendees could see those of particular interest rather than a cursor & book (i.e., 15 min) at all.

****

Use of Boeing Hotnews or Macon "MAIC" System

Use the ECPL Incl Abstracts

The interchange of ideas among individuals has been very good. Discussion periods of the entire group is very informative.

******

Many people are using the low speed terminals these days and this is a very good method of disseminating information. The "Hotnews" file has been very helpful to us. This method leaves the responsibility with the individual which I feel is important. Why not have small regional meetings periodically? I would like to see a list of "experts" and their fields and phones.

Who's Who of <u>all</u> Corps employees involved with development of graphics programs and systems.

Very well balanced as far as workshop and lectures, users of equipment and ADP personnel and time alloted to each presentation. Good job of planning.

******

By putting the list of information on system whereby it can be obtained on a terminal system.

The GCS package could be more universally accepted if a program were available to convert source code from existing programs written in at least PLOT-10 and Calcomp code to GCS. This would allow updating and enhancing existing programs all in one language, GCS.

Less stringent requirement for documentation for Corps library programs.

REMARKS (Continued)

Your definition of interactive graphics makes some interactive graphics applications (by your def.) a pain in the ass to use. Should be able to type in commands instead of moving X-hairs around.

Not detailed enough - need more time to look at things of special or specific interest.

******

Publish or document containing examples of all good graphics outputs.

The interactive session was very interesting and helpful.

More graphics applications on Boeing.

Presentations in workshops could have been beter prepared. It seems that they were not quite adequately prepared for their presentations. A suggestioed presentation method might be in order for the next colloquium.

More on speculating the direction and future of graphics in the Corps. Color, speeds, growth analysis, etc.

Suggest establishing more CASE committee involving the districts to develop document and disseminate programs. Believe that with a number of Districts involved broader acceptance and usage will occur among all districts. Also suggest more specific direction from OCE as all districts wants to develop their own systems. However, with the expanded use of computer systems, I do not foresee any means to maintain control without specific direction and some standardization.

We have adopted the practice of internal documentation in the source code itself - I think it can be standardized - if so it could also serve as a source of information to put at Boeing.

I had hoped there would have been online work time for those of us w/o graphics terminals and then been able to justify their needs in our operations.

Keep a publishing program names and discriptions of what they do.

Too short

REMARKS (Continued)

Future colloquiums might provide concurrent sessions with some workshops for ADP and others more specifically oriented to user applications.

******

Work graphics programs into courses being presented to engineers (i.e., T-Wall course, Sheet-Pile Course, Soil Courses, STRUDL, etc.)

Colloquium needs to be more general - specific applications are somewhat out of place because uses are generally restricted. Availability would be more appropriate.

*****

Mr. Hardin's request for office symbols is a good step. If dissemination is left to ADP, engineers won't always see it. A mailing list should be established and used reguarly.

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Possibly each district/division could collect workdone bi-annually for submission to GUC.

Well organized could have used more information on structural applications.

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Have a certral office or organization responsible for obtaining, checking, and documenting program listings.

I am very much in favor of the use of the Corps vendor (Boeing) as a means of communications and sharing of graphics applications. Of course, training is an important step. Also, I think that the local ADP offices should be assessed by perhaps GUC to determine if the users are getting enough attention.

Too hurried. Spread it out over a longer period.

Colloquium was very successful due primarily to the excellent amount of organization that went into it.

OCE funding of existing plot programs to improve documentation and ease of use.

Good base to move from. As with anything new it needs some work. More organization on part of presentor (self included). Parallel sessions might be set up to allow a variety of presentations to attend. (i.e., if I don't want to sit thru HEC2, I can go to another presentation).

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Controlling center keeping up on a library type file.

REMARKS (Continued)

I think getting a list of applications on-line with BCS as planned by GUC is an excellent way of dissemination.

Keep lists of available programs but keep required documentation streamlined.

Oriented too much to ADP personnel and not toward actual engineering users.

An easily usable program library is a must for the near future. A system and device independent graphics language should be recommended for Corps-wide usage to improve interchanges of programs. Future co-loquiums should have a session on hardware problems and a system should be set up to disseminate information on hardware problems.

Too many private jokes between speakers and audience. Have colloquium for <u>specific</u> applications, e.g., business, management, hydraulics, structures.

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Have specific topic colloquium as mentioned on page 1.

Interactive graphics users are generally non-ADP people and more of these people need information concerning graphic programs and software uses.

It should be possible for people to spend more time in sessions in which they have particular interest, and less or no time in sessions in which they have little interest.

Keep updated list of available programs by subject in library on Boeing.

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On-line index and abstracts at BCS.

Increase frequency of information dissemination.

The on-line abstract system offers the most advantages of any method for dissemination of program available.

SUMMARY/RECOMMENDATIONS

[redacted]

SUMMARY AND RECOMMENDATIONS

Summary

The purpose of the colloquium was to determine the state-of-the-art in using Computer Graphics in the Corps and to disseminate the findings to the engineers. Ninety four people attended the colloquium. The attendance was divided 43% ADP personnel and 57% engineer computer users. The attendees represented 43 Corps offices and 75% of them were non-supervisory personnel.

As a result of the Colloquium 87 computer graphics programs, developed in 36 Corps offices, have been identified as having potential use by other or all Corps field installations. A survey indicated that the Corps uses many graphics software packages. The distribution of the languages used is as follows:

CALCOMP	48%
GCS	28%
GPLOT	12%
All others	16%

There was almost an unanimous feeling amongst the participants that the Colloquium met their expectations and computer graphics could be a cost effective tool for the engineers. Seventy-seven percent of those attending felt that the colloquium program was well balanced. Eighty five percent of those attending recommended the adoption of a 'standard or preferred' graphics language for the Corps. Further, of those knowledgeable of graphics languages, 95% percent recommended GCS as the standard.

Perhaps the most significant achievement of the colloquium was that 62 percent of those attending said that they are taking back to their offices one or more graphics applications that can be used immediately.

Recommendations

Software development must be actively coordinated to prevent duplication in development of graphics programs. A first step to accomplish this objective is to provide a Corps-wide standard (or preferred) graphics language for development of applications. The framework for such a standard computer graphics language now exists in the Corps. Enhancements and refinements to the GCS can make it a very viable candidate for Corps-wide use. Adoption of a standard language will result in cost savings by promoting

program transportability, avoiding duplicate program development efforts, and reducing maintenance efforts.